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HOW TO EXAMINE THE CHEST

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A PRACTICAL GUIDE FOR THE USE OF STUDENTS

BY

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PREFACE.

In the following pages I have not aimed at writing an exhaustive treatise on auscultation and percussion, but merely an introduction to the examination of the chest by these and other methods. Each section is virtually based on lectures delivered by me at St. Bartholomew's Hospital, during the course of the demonstrations, which it has been my duty, as medical tutor, to give to the students during the last few years, by way of preparation for clinical work in the medical wards. I have therefore avoided all discussion of theory, and have adopted in the text, without argument, that theory in each case which appears to me on the whole to furnish the best explanation of the facts.

I have endeavoured throughout to keep clearly in view the wants of beginners, and to write a simple and concise account of the main facts of prominent importance, describing what seems to

me the best method of observing these facts, and showing the use which may be made of them for the purpose of diagnosis.

I am much indebted to Dr. Andrew and Dr. Bristowe for their friendly criticism and advice, which I take this opportunity of gratefully acknowledging.

SAMUEL WEST.

15 Wimpole Street,
Cavendish Square, W.
March, 1883.

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HOW TO EXAMINE THE CHEST.

INTRODUCTORY CHAPTER.

THE THORAX.

The **Chest** or **Thorax** is a box, the sides of which are formed by the spine, the ribs and intercostal muscles, and the sternum.

Above, it is closed by muscles and membrane, between which the vessels and other structures pass into, or out of, the cavity of the chest.

Below, it is completely closed by the diaphragm, which is attached, posteriorly to the spine, anteriorly to the sternum, and all round to the free margin of the ribs, or, as it is called, the **Costal Arch.**

The Parts of the Thorax.

Externally, the thorax is mapped out into certain regions (*figs.* 1 *and* 2), named according to the anatomy of the part:

In the middle line, the **Sternal**, divided into
the **Upper** and **Lower Sternal**, with
the **Episternal** above:
On either side of the sternum,
the **Parasternal**:
Further outwards,
the **Clavicular**,
the **Supraclavicular** and **Infraclavicular**,
the **Mammary** and **Inframammary**:
Laterally,
the **Axillary**, upper and lower:
Posteriorly,
the **Supraspinous**, and **Infraspinous**,
the **Infrascapular** and the **Interscapular**.

These terms are useful as indicating roughly the particular region under examination, but, when greater accuracy is required, the locality should be fixed by reference to parts of the bony framework, such as the ribs, sternum, &c.

Measurements are often taken from the nipple as a fixed point, or from a vertical line passing through the nipple, and called the **Nipple line**; but from the varying position which the nipple occupies, in different persons, especially in women, such measurements are not satisfactory.

The line which is usually described as the nipple line is a vertical drawn from the middle point of the clavicle downwards. This cuts the edge of the costal arch, usually at the tip of the

eighth rib, and in ordinary cases passes through the nipple.

The Contents of the Thorax.

The thorax contains:

1. The **Lungs.**
2. The **Heart.**
3. The parts in the **Mediastinum.**

Closely related as all these organs are to one another, it is impossible to limit our examination absolutely to one or other of them; but for convenience we may divide our subject in this way, making reference, in our description of one organ, to the others, only so far as may be necessary for clearness.

Position of the Patient.

When the chest is being examined, it should, if possible, be completely bare.

To examine the front of the chest, the patient should stand, or sit, straight up, with the arms hanging down, or, if lying down, should be flat upon the back, with the arms by the side and the legs straight.

To examine the back of the chest the patient should sit or stand with the arms folded, the shoulders rounded, and the head bent forward, so as to make the back as broad and round as possible, and to widen the interscapular spaces.

FIG. 1

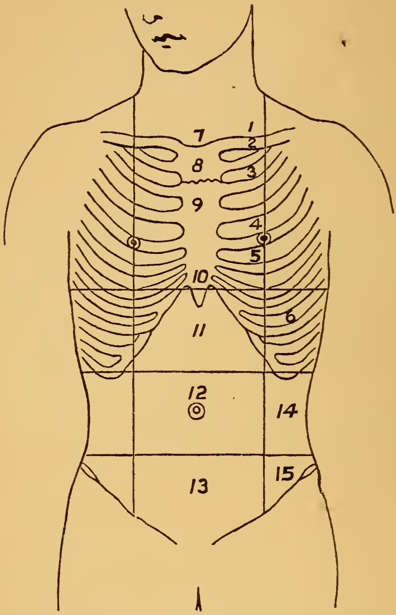


Diagram of the front of the thorax and abdomen.

The vertical lines are the nipple lines. The figures refer to the named regions.

1. The supraclavicular.
2. The clavicular.
3. The infraclavicular.
4. The mammary.
5. The inframammary.
6. The hypochondriac.
7. The episternal.

8, 9, 10. The upper, middle, and lower sternal.

11. The epigastric.
12. The umbilical.
13. The hypogastric.
14. The lumbar.
15. The inguinal.

FIG. 2.

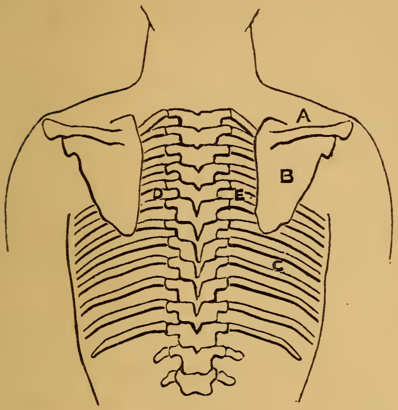


Diagram of the back of the thorax. The letters refer to the named regions.

A. The supraspinous.
B. The infraspinous.
C. The infrascapular.
D, E. The interscapular.

The Methods of Examination.

In our examination of the chest we use the senses of sight, touch, and hearing, and we arrange our observations accordingly, under the three heads of:

1. **Inspection**, *i.e.* what we can see.
2. **Palpation**, *i.e.* what we can feel.
3. **Auscultation** and **Percussion**, *i.e.* what we can hear.

These methods are applicable to all parts of

the body, though not in an equal degree, but they are of chief importance in the examination of the chest.

Any other methods which may be available in certain cases will be referred to and described as occasion arises to make use of them.

It is desirable, so far as possible, to represent in a graphic form all the information we obtain. Ways of doing this will be suggested as opportunity offers.

We shall commence with the systematic examination of the lungs, then proceed to the examination of the heart, and lastly, of the mediastinum.

Our observations will be arranged in order under the heads of **Inspection, Palpation, Percussion, Auscultation.**

SECTION I.

THE LUNGS.

THE EXAMINATION OF THE LUNGS.

INSPECTION.

When we inspect, or look at, a chest we have two sets of facts to observe:

1st. Those, which we can observe as well in a dead as in a living person, viz. the **Shape** or **Form** of the chest:

2nd. Those, which are only seen during life, viz. the **Movements** of the chest during respiration.

I omit, for the present at any rate, all those phenomena not associated with the form or movements of the chest, such as dilated veins, &c, as not immediately connected with the examination of the lungs.

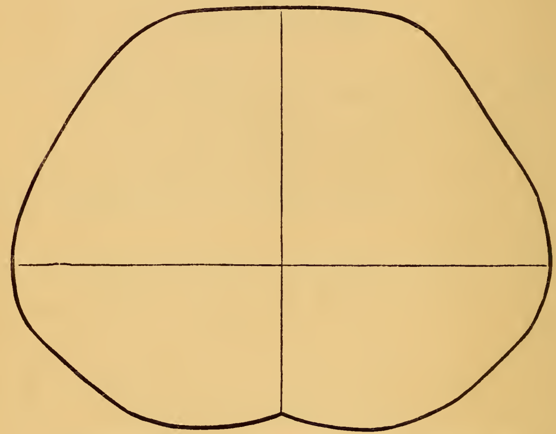
THE SHAPE OF THE CHEST.

This admits of great variation, even within the limits of health, so that there is no fixed normal or physiological type.

Average Measurements of Healthy Chests.

The healthy adult thorax (*fig.* 3) is wider than it is deep, that is, it measures more transversely than from front to back. In a fully-developed *man* the average measurements are transversely

FIG. 3.



Healthy chest. Cyrtometer tracing reduced.

9 to 10 inches, and antero-posteriorly 6 to 7 inches. In *women* these measurements are about 1 inch less.

These are of course only rough averages and vary much in different individuals. In *children* the two diameters are nearly equal, so that the shape becomes almost circular.

The apparatus required for measuring the chest consists of:

1. A measuring tape.
2. A pair of callipers.
3. A cyrtometer.

The **Cyrtometer** is an apparatus by means of which a life-size tracing may be obtained of the shape of the chest.

There are many forms of cyrtometer, but the most convenient, and that in ordinary use, is made of two pieces of composition gas-piping, each about eighteen inches long, and joined together by a hinge or piece of gutta-percha tubing.

The method of using this apparatus is as follows:

The patient's chest being bare, a mark is made at the base of the xiphoid cartilage in front, and another posteriorly upon the spine, on the same horizontal level. With a pair of callipers, the measurement is taken between these two points, and two marks made upon a sheet of paper, corresponding with the points of the callipers, "spine" being written opposite one, and "sternum" opposite the other.

The cyrtometer is then taken, the hinge placed upon the mark upon the spine, and the soft piping bent round the ribs, until the two arms meet at the mark in front. A little careful

moulding causes the piping to take the form of the chest. A mark is now made upon the piping in front, to indicate the spots upon the two arms corresponding with the middle line of the sternum. The cyrtometer is then held by the hinge, and the two arms allowed to fall off the chest by their own weight, care being taken that they are not twisted in any way, as they are removed.

The whole apparatus is now laid upon the sheet of paper, so that the hinge corresponds with the spine mark, and the marks upon the cyrtometer in front, with the sternum marks. A pencil is carried round the inside of the arms, and an exact tracing of the shape of the chest is thus obtained.

Lastly, the words "Right" and "Left" are written on the corresponding sides, and the tracing is complete.*

Named Varieties of Thorax.

The different forms of chest are for the most part described by ordinary terms, such as long and short, broad and narrow, deep and shallow, and all of these various forms may be quite consistent with health.

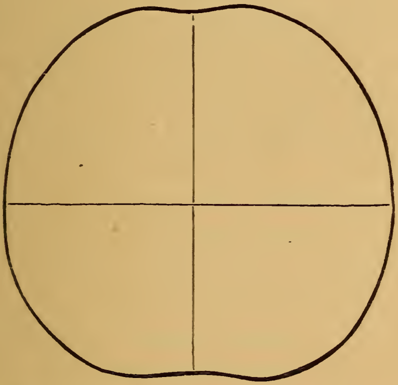
* By means of a very simple apparatus, such as the pantograph, a cheap form of which may be purchased now for one shilling, these large tracings may be quickly reduced to a convenient size for the note book.

Certain marked deviations from the normal form have, however, received special names. These are :

1. The **Barrel-shaped** chest.
2. The **Rickety** chest.
3. The **Pigeon-breast.**
4. The **Alar** chest.

The **Barrel-shaped Chest** is, as its name implies, like a barrel (*fig.* 4). It is almost

FIG. 4.



Barrel-shaped chest. Cyrtometer tracing from a case of emphysema reduced.

This is very like the tracing obtained from an infant's chest, which is also nearly circular in shape.

circular in section. Its transverse and antero-posterior diameters are almost the same. The sternum is bowed forwards, and the spine often

backwards, so that, in profile, the outline is usually distinctly bi-convex.

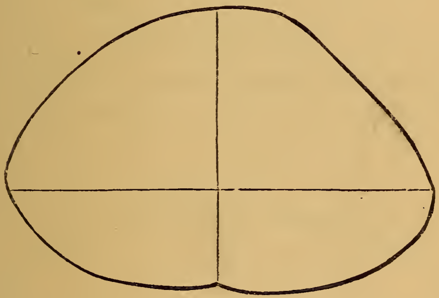
This form is always associated with a pathological change in the lungs, to which the name **emphysema** is given.

The other peculiar forms of chest are not necessarily associated with any change in the lungs. They are due to causes which were at work when the chest was developing in childhood, at a time when the ribs were soft and yielding, and are evidence rather of past than of present disease, although in all these cases it is very common, that the lungs are weak, and that they subsequently become affected.

The **Rickety Chest** gives a tracing such as is shown in *fig.* 5. The longitudinal furrow at the sides of the sternum corresponds with what was in childhood the ossifying end of the ribs. Most rickety children suffer much from bronchitis, and the bronchi in children become easily plugged. When this is so, the air cannot enter freely into the air vesicles, and on inspiration the chest walls are driven in by atmospheric pressure. The softest parts yield most. These are, of course, the ossifying ends of the ribs and cartilages, which are, moreover, in rickets especially soft and yielding. If this condition lasts for any length of time, it may become permanent and give rise to the rickety form found in adults.

In rickety children a deep transverse furrow running across both sides of the chest below the nipples, about on a level with the fifth space, is often seen. This is called **Harrison's furrow.** When well marked, its causes are the same as that of the rickety chest. It is most evident on the right side and corresponds with the upper border of the liver in childhood. It may be traced, though often indistinctly, in most healthy

FIG. 5.

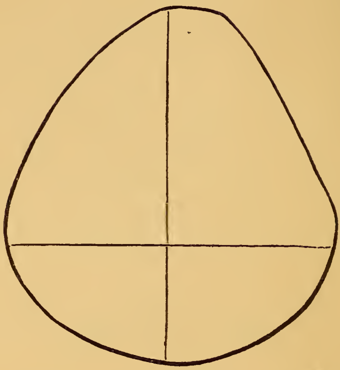


Rickety chest. The diagram shows a slight want of symmetry as is not uncommon in these cases.

adults, but when excessive, is usually evidence of past lung affection.

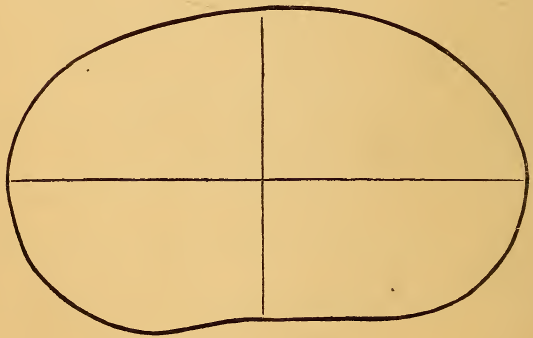
In the **Pigeon-breast** (*fig.* 6) the sternum is protruded and the ribs straightened out at the angles and at their junctions with the cartilages. In external appearance it resembles, as the name

FIG. 6.



The Pigeon-breast. Here also is a slight want of symmetry.

FIG. 7.



The Alar or Pterygoid Chest. This is a good instance of a tracing of a flat chest.

implies, the carinate or keel-shaped breast of a pigeon.

This is merely a variety of the rickety chest, and is due to the same causes.

In the **Alar Chest** or **Pterygoid Chest** (*fig.* 7), the upper parts of the chest, viz. the sternum and neighbouring ribs, are flattened and sunken. The shoulders in consequence fall forward, and thus throw the posterior and lower borders of the scapulæ off from the ribs, so that they are tilted outwards and project like rudimentary wings (alæ), whence the name.

With this peculiar deformity, the muscles connected with the upper part of the thorax are usually imperfectly developed or atrophied, and in consequence, this has been also called the **Paralytic** form of thorax.

This, like the other forms, though presumptive of disease of the lungs, is not necessarily associated with it.

The healthy chest is as nearly as possible symmetrical in all its parts. Any want of symmetry, even though it be but slight, is most important evidence of disease, either past or present.*

* The right side of the chest usually measures about half an inch more in circumference than the left; probably in connection with the greater development of the muscles on the right side in right-handed persons, but this does not give any appearance of asymmetry to the eye.

Changes of Shape due to Disease.

In disease the changes of shape may be of two kinds. There may be—

1st. Increase in size, or as it is usually called, **Bulging**;

2nd. Decrease in size, or **Contraction.**

These changes may affect both sides, *i.e.* be **bilateral**, or only one side, *i.e.* be **unilateral**, and in either case they may involve either the whole of the side, or only part of it.

Even where the change is bilateral, it is rarely absolutely symmetrical.

Symmetrical bilateral increase in size is only met with in the barrel-shaped chest of emphysema.

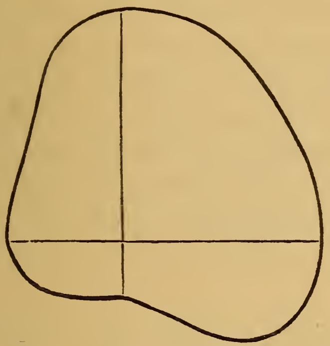
Symmetrical bilateral decrease in size occurs only in the opposite condition, in which both lungs are uniformly shrunken, and more rarely also in the paralytic, alar, and other forms of chest described above.

With these exceptions, changes in shape are always unsymmetrical, and it is therefore for a **Want of Symmetry**, *i.e.* for a difference between the corresponding parts of the two sides of the chest, that we chiefly look as evidence of disease (*fig.* 8).

When there is such a want of symmetry it is sometimes difficult to say whether this want is due to a bulging of one side, or to a shrinking of

the other. Further examination only can determine this question.

FIG. 8.



An extreme instance of want of symmetry. The tracing was taken from a child in whom the left side was contracted after an empyema.

Deformities.

In certain trades, for instance, among carpenters, weavers, and shoemakers, a depression is often found at the bottom of the sternum, sometimes of considerable depth. This is usually due to pressure during work (as by the last, auger, or weavers' beam), though the deformity is occasionally congenital.

The Condition of the Superficial Veins.

Except where patients are very thin, the veins are rarely visible in health beneath the skin.

In disease they are often dilated and frequently unsymmetrically so. When this occurs, the direction in which the blood is travelling should be determined. This is done by placing two fingers upon the most prominent vein, and then drawing them apart along the vein in order to press the blood out. By raising first one finger and then the other, it will be clear from which direction the vein fills most easily. This will be then the direction, in which the blood is travelling.*

THE MOVEMENTS OF THE CHEST ON RESPIRATION.

These are alternately movements of expansion and contraction, called inspiration and expiration. On inspiration the chest expands in all directions. The sternum moves forward, the ribs rise, the intercostal spaces widen, and the diaphragm descends. These movements are freest in the lower parts of the chest. They are partly thoracic and partly diaphragmatic.

In women and children the ribs move most, and the respiration is called **Thoracic** or **Costal.**

In men the diaphragm moves most, and the respiration is called **Diaphragmatic** or **Abdominal.**

* Enlarged subcutaneous veins over the mammæ and upper part of the chest are usual in women who are suckling, or who have had children. This is, of course, physiological.

A change of type from costal to abdominal or *vice versâ* is often an evidence of disease.

The **Measurements** of the chest are constantly varying. The average circumference of a healthy man's chest at the level of the nipple is after expiration about 32 inches, and after inspiration about 35½ inches, giving thus a difference on the average of each respiration of 3½ inches, or about one twelfth. On forced respiration the difference can sometimes be made much greater.

These measurements in women are somewhat less.

The **Amount of Air**, which is taken in and out, will depend upon the amount of the respiratory movement of the chest.

In ordinary breathing it is calculated that on the average about 30 cubic inches are drawn in at each inspiration, and the same quantity emitted at each expiration. About 100 cubic inches more may be squeezed out on forced expiration, and about the same amount more taken in on forced inspiration. Making the total maximum quantity of air which can be inspired or expired about 230 cubic inches.

Instruments have been devised for measuring the **Vital Capacity** of the chest, *i.e.* the total amount of air, which can be taken in, or forced out, by the deepest possible respiration. They are known as **Spirometers**, but hitherto they

have not been found to be of much use in diagnosis.

Alterations in the Respiratory Movements.

When the respiratory movements are increased in range above the normal, we speak of them as **Exaggerated**; when decreased below the normal, we speak of them as **Impaired** or **Deficient.**

When the movements are deficient, less air will enter the lungs than is necessary, and the patient will suffer from shortness of breath, or as it is called **Dyspnœa** (bad breathing).

Dyspnœa may be the result of deficient respiratory movements under two opposite conditions, for the lungs may be prevented either from expanding, or from contracting, as much as they should. The former is spoken of as **Defective Inspiration** or **Deficient Expansion**, and the dyspnœa is called **Inspiratory**; the latter, as **Deficient Expiration**, and the dyspnœa is called **Expiratory.**

When the patient cannot lie down on account of the difficulty in breathing, it is called not dyspnœa, but **Orthopnœa** (orthos, upright).

When from any cause there is obstruction to the entrance of air, the deficient expansion of the lungs will make itself manifest in the softer parts of the thorax, *i.e.* in the intercostal and supra-clavicular spaces, and they will sink in somewhat

during inspiration. This is called **Inspiratory Recession.**

When the obstruction is considerable, not only the soft parts, but also the ribs, especially the lower ones, yield, and are sucked in during inspiration. In its most extreme form, this is met with in children suffering from croup, and where the obstruction is of long standing, or oft repeated, as has been stated already, it is the cause of certain deformities, which may be permanent (p. 14).

The exactly opposite condition to inspiratory recession, viz. **Expiratory Bulging** of the intercostal and supraclavicular spaces, is common in cases in which the elasticity of the lungs is reduced, and the expiration obstructed.

It is most marked during a fit of coughing, in patients suffering from extreme emphysema.

The Number of Respirations is about 14 to 18 in the minute, and bears to the pulse, on the average, the relation of 1 to 4.

On quiet respiration, the movements occur at regular intervals, though they are largely influenced by emotion and excitement, both as regards number and regularity.

Except in children and in cases of hysteria, the number, even in disease, rarely exceeds 40 to 50. As a general rule the more rapid the respirations, the more shallow they are.

The movements of respiration, in healthy persons at perfect rest, as for instance when asleep, follow one another at regular intervals, the rhythm being maintained by the action of the nerve centres in the medulla oblongata.

The movements are to a very great extent under voluntary control, and may therefore be made to vary much by the action of the will, as in speaking, singing, &c., but irregularity is often independent of the will, and is due then to interference with the action of the respiratory centre, usually in response to reflex irritation from some other part. Thus, mental emotion may lead to laughing, crying, sobbing, &c., irritation in the lungs or stomach to coughing, hiccough, &c.

Of all forms of irregular respiration the most peculiar is that known by the name of **Cheyne-Stokes' Breathing.***

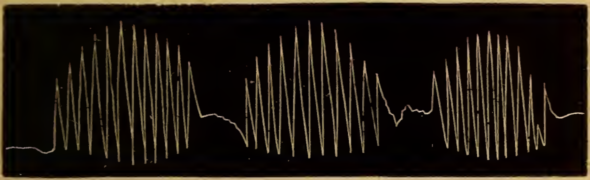
In this form the respiration at times ceases for some seconds, and then recommences, the movements being at first small and rapid, becoming gradually deeper, and often at the same time slower, until the maximum expansion of the chest is reached, when they decrease in the same manner, until again for a time the movements cease (*fig.* 9).

In all these cases the movements still remain

* Dr. Cheyne first observed it and Dr. Stokes subsequently more minutely described it.

symmetrical. They are altered in their general rhythm, but not in symmetry. When the movements are unsymmetrical, there is some local disease, past or present, to account for it.

FIG. 9.



A semi-diagrammatic tracing of Cheyne-Stokes' Breathing. The upstrokes represent inspiration, the downstrokes expiration. The more or less horizontal line indicates the pause in respiration.

Inspection of the chest presents but few difficulties, if it be remembered, that, with the exceptions to which reference has been made, what we have to look for is not a departure from some ideal normal type to be carried in the memory, but simply a want of symmetry, or similarity, between the two sides of that particular chest, which we are examining.

When this want of symmetry exists, there must be some condition of disease, past or present, to account for it.

SYNOPSIS.

On Inspection then we note—

I. The shape of the Chest:

- Barrel.
- Rickety.
- Pigeon.
- Alar.
- Paralytic.
- Shoemakers', Weavers', Carpenters'.
- Harrison's Furrow.
- Defects of Symmetry.

II. The Movements of the Chest:

- their number,
- their regularity,
- their type, costal or diaphragmatic,
- if impaired,
- or exaggerated.
- Defects of Symmetry.
- Dyspnœa { Inspiratory. Expiratory.
- Orthopnœa.

PALPATION.

The first thing to be done on palpation is to **Count the Ribs**, and, simple as this seems to be, mistakes are often made. It will be easily and correctly done, if it be remembered, that the first rib, which we can get comfortably between two fingers, is the second. It is easier to count the spaces than the ribs, and we know, that the rib corresponding to the space lies above the space.

Our landmarks, as we shall see, are all determined with relation to the ribs and spaces.

THE SHAPE AND MOVEMENTS.

Nearly all that can be seen can be also felt, but sometimes, in case of difficulty, the hand may help the eye. This is especially the case with the movements of the chest. For this purpose, the hands must be placed symmetrically upon symmetrical parts. If at the apices, the thumbs should be placed together upon the sternum, and the fingers allowed to rest beneath the clavicles, or, in children, the thumbs may be placed in con-

tact upon the spine, and the fingers bent over the shoulder, so as to rest upon the upper part of the chest in front. In either of these ways very slight differences in the amount of movement upon the two sides may be detected.

The **Widening of the Intercostal Spaces** on inspiration may be easily observed, by placing the hands upon the lower part of the chest or in the axilla and spreading the fingers so that they lie in the intercostal spaces.

We are able in this way to determine:

1. If the spaces be narrower or wider on one side than on the other;
2. If they be retracted or unduly prominent;
3. If the expansion or widening on inspiration be sufficient in amount, and equal on the two sides.

Abnormal Sensations.

Occasionally the grating of **Pleuritic Friction**, (*q. v.*), the wheezing of **Rhonchus** and **Sibilus**, (*q. v.*), or the crackling of **Crepitation**, (*q. v.*), may be felt.

VOCAL VIBRATIONS.

If, while the hand is placed upon the chest, the patient be made to speak, the vibrations of the voice will be felt by the hand. They are called **Vocal Vibrations.** They may be also heard, if the

ear be placed upon the chest, as we shall see under "Auscultation," and then they are spoken of as **Vocal Resonance.** There is no real difference between them except one of terms. We feel vocal vibrations, and we listen to vocal resonance. As the ear is more sensitive than the hand, so we can occasionally hear the vocal resonance, when we cannot feel the vocal vibrations. This is especially the case in women and children, in whom the vibrations of the voice are not intense.

The louder the voice, the deeper or more bass the tone, and the thinner the patient, the more easily will the vibrations be felt. The other conditions, which alter the vocal vibrations, will be discussed later under the head of "Auscultation," when we speak of vocal resonance.

For the present it is sufficient to say, that the same want of symmetry in the physical signs, which we look for on inspection, is to be searched for also on palpation. It is this want of symmetry, which is of the chief practical importance.

Sense of Resistance.

If the intercostal spaces be lightly tapped with the tips of the fingers over the upper part of the chest, a sensation of elasticity or springiness will be obtained. If, however, the same thing be done, where a solid organ lies beneath the chest walls,

as over the liver, the sense of elasticity will be lost, and, in its place, the fingers will experience a feeling of resistance.

The same thing happens, if the lung becomes solid, or if it be separated from the chest walls by changes in the pleura. To this feeling the name **Sense of Resistance** is given. It is, however, of no great practical importance.

Where, in disease, there is a large collection of pus in the pleura, **Fluctuation** may sometimes be elicited in the usual way. It is not, however, at all common.

SYNOPSIS.

On **Palpation**, then, we proceed to **count the ribs**, and next to observe :

1. **The Shape and Movements of the Chest.**
2. **The Vocal Vibrations.**
3. **The Sense of Resistance.**
4. **Abnormal Sensations**, when present, such as friction, crepitation, rhonchus, sibilus, or possibly fluctuation.

PERCUSSION.

By **Percussion** is meant the method of striking the walls of the body, so as to cause them to yield a sound.

We must consider, then, 1st, the best way of producing sound by percussion, and 2ndly, the kinds of sounds, which may be produced, and what meaning and value we may attach to them.

Percussion may be **direct** (immediate), when we percuss upon the skin directly, or **indirect** (mediate), when we percuss upon something placed upon the skin.

In the examination of the Chest **Direct Percussion** is not employed now except upon the clavicles and the spine of the scapula, where, from the absence of much covering, the sound produced is not interfered with.

For **Indirect Percussion** we require: 1st, something to strike with, and 2ndly, something to strike upon.

Apparatus of various kinds has been devised for this purpose:—1. Hammers, or, as they have been called, **Plessors**, of various sizes, shapes, and substances, to strike with. 2ndly. Flat plates, (**Plessimeters**) of metal, wood, or ivory, to strike upon.

These forms of apparatus have been almost entirely abandoned, and in their place we are in the habit of using the fingers of one hand, as our plessor, to percuss with, and one of the fingers of the other hand, as our plessimeter, to percuss upon.

In this way we combine, with percussion, those sensations described in the previous chapter under the head of "Sense of Resistance." This method of percussion has been called **Palpatory Percussion.**

The tip or pad of one finger, say the middle, is the head of the hammer, the rest of the hand, the handle.

The blow should be light, but firm, produced by a free action of the wrist, as in playing octaves upon the piano. This is difficult to acquire, but can be well practised by placing the whole forearm, from the elbow to the fingers, flat upon a table and then percussing, the forearm being firmly pressed down with the other hand, to keep it fixed, and to prevent its being raised from the table.

The hammer of a piano forms the best illustration of the kind of movement we require. When a note is struck upon the key-board, the hammer is driven sharply against the wire, but does not remain more than an instant upon it, quickly recoiling and leaving the wire free to vibrate.

This is what the hand should do. The finger should deliver a short, sharp stroke, and immediately return from contact with the chest. It will require much practice to get this proper movement.

Sometimes, instead of the tip of one finger, the tips of two or three are employed. This has no special advantage, except, that as the head of the hammer is broader, a greater surface is thrown into vibration, and therefore the sound is somewhat louder, but, if more fingers than one are used, care must be taken that the pads of the fingers are all upon the same level, so that they may all strike the chest at the same time. This, again, can be practised best upon the table, by pressing first the tips of the fingers firmly down to get them level, then raising them, fixed in that position, and proceeding to percuss.

In choosing a finger to percuss upon, one should be selected which is not bandy, so that it may lie perfectly flat. It matters little which is chosen. For convenience, it is generally either the index or the little finger.

The object we have in view in percussing the chest is to throw into vibration the parts beneath the walls of the thorax. We must, therefore, avoid as much as possible all interference with these vibrations from the walls themselves. This we do by placing the finger upon which we percuss

perfectly flat upon the chest, and exercising slight pressure, so as to condense the tissues immediately beneath. If the finger be placed loosely, instead of firmly, upon the skin, and still more if it be not in all parts quite in contact the percussion note will be impaired.

In order that there may be as little of the walls as possible for the vibrations to pass through before reaching the organs beneath, we must percuss straight upon the surface, that is, perpendicularly to the walls and not in a slanting direction.

To sum up—

1st. Our hands form our only apparatus.

2nd. The finger percussed upon must be placed flat, and pressed firmly upon the chest.

3rd. The blow must be from the wrist, light, short, firm, and delivered at right angles to the chest walls at the part percussed.

Good percussion is difficult to acquire, but is worth all the time and trouble spent upon it.

Resonance and Dulness.

When we percuss upon the walls of a cavity containing air, as, for instance, over a drum, we obtain a hollow or, as it is called, a **resonant** sound.

When we percuss upon a solid mass, like the thick part of the thigh, the hollow sound is not

produced, and the sound which is produced is called **non-resonant** or **dull.**

Many varieties of resonance and non-resonance are described, but it is sufficient for us at present to recognise the difference between sounds which are resonant, and those which are non-resonant.

Over the lungs the note is resonant, because the lungs contain air. Over a solid organ, such as the liver, the note is non-resonant or dull.

The Size of the Lungs.

We are now in a position to apply these facts practically.

How large are the Lungs? This is naturally the first question of importance, and percussion alone enables us to answer it. For the lungs are in direct relation with solid organs, and, where these are, the note, which over the lungs has been resonant, will become non-resonant or dull. If we mark upon the skin of the chest the places where this occurs, we obtain certain lines. These are called **Surface Markings,** or **Medical Landmarks.**

These landmarks indicate certain relations in which the organs stand to the outer parts of the body. They must not be confounded with the anatomical boundaries, sizes, and shapes, of these different organs, with which they only approximately

Fig. 10.

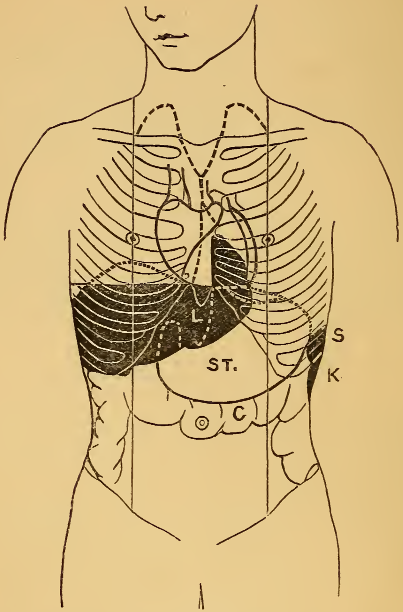


Diagram showing the position of the great organs of the thorax and abdomen with their surface markings.

L, *Liver*. ST, *Stomach*. S, *Spleen*. K, *Kidney*. C, *Colon*.

The *Lungs* are left unshaded. Their upper and anterior boundaries only are shown by a dotted line.

The *Heart* is represented of its anatomical size, and upon it in black is indicated the size of the absolute cardiac dulness.

The *Hepatic dulness* is represented in black. The dotted line above, on the right side, shows the position of the upper part of the liver, and therefore of the vault of the diaphragm deep within the thorax. Just outside the right nipple line, at the edge of the ribs, the little excrescence marks the position of the *Gall-bladder*.

The *Stomach* is indicated partly by dotted and partly by continuous line. The area of stomach resonance lies between the dotted line on the left side and the margin of the costal arch.

The anterior part of the *Spleen* and *Kidney* are indicated in black.

correspond. For example, the surface-markings of the heart enclose a space (the cardiac area), which is small compared with the real size of the heart (*fig.* 10), but it is of the greatest importance for the reason that, so long as the organs in immediate relation with the heart are normal, the space varies in size and shape in direct proportion with any change in the heart itself.

The medical landmarks and anatomical boundaries are therefore not the same thing, and though closely related must not be confused one with the other.

The Boundaries of the Lungs.

The lungs are in close contact with the ribs along their whole length.

These are, therefore, their natural **External Boundaries.**

The apex of each lung rises as a blunt cone into the neck as far as an inch and a half above the clavicle. The curved line, which corresponds with the apex and sides of this cone, can be easily percussed out, and gives the **Upper Boundary.**

The edges of the lungs approximate **anteriorly** beneath the manubrium sterni, and come in contact at a point corresponding with the junction of the second costal cartilage with the sternum; they remain in close approximation down as far

as the level of the fourth costal cartilage. From this point the anterior margin of the right lung continues onward down to the bottom of the sternum, sloping slightly away to the right side, while that of the left bends sharply away to the left side, to a point about two inches and a half from the bottom of the sternum. This leaves a roughly triangular space between the two lungs, in which part of the pericardium is uncovered. It corresponds with the area of cardiac dulness. (*q. v.*).

The **Middle Boundary** cannot be determined by percussion for this reason. The sternum is a solid bone, which lies for some distance in close relation with the lungs. When, then, it is percussed, even in a part, where only solid structures lie beneath, as under the upper part of the manubrium, or under the lower part over the heart, the vibrations are transmitted to those parts which lie over the lungs, and so to the lungs themselves, and, in consequence, the note in any part of the sternum will be equally resonant.

The **Lower** boundary is of course the diaphragm, but this is too thin to define by percussion, so that we can determine its position only by means of the organs in relation with it; these are, the liver, the stomach, and the spleen. Two of these organs, the liver and the spleen, are solid bodies, and will give, therefore, a non-resonant sound.

The stomach contains air, and will, therefore, give a resonant sound.

Percussion will enable us, then, to determine where these organs are, and in this way where the diaphragm is. On the right side the termination of the lungs will be marked by a line of non-resonance, or dulness, corresponding with the liver, and on the left side by a line of altered resonance corresponding with the stomach, and by a line of dulness corresponding with the spleen.

Before, then, we can determine how large the lungs are we require to know what the upper boundaries of the liver, stomach, and spleen are in health, *i.e.* the surface-markings corresponding with these organs.*

The Surface-Markings of the Liver.

If a piece of string be taken and one end of it be placed upon the apex of the heart, *i.e.* in the fifth left intercostal space, one inch inside the nipple line, and the rest be carried almost horizontally, but with a slight inclination downwards, round the right side of the chest to the spine, this will represent the surface-marking usually

* In ordinary respiration the lungs do not quite come up to the edge of the pleura; the small space left is called the *complemental space.*

described as the **Upper Boundary of the Liver.** It will correspond, in the right nipple line, with the upper border of the sixth rib, and, as the ribs are curved downwards, it will cut the eighth, ninth, and tenth ribs as it passes backwards.

This line marks the limit of absolute dulness, for, as the liver rises anatomically above this line deeper in the chest, forcible percussion will give a note of impaired or defective resonance, often as much as an inch higher.

This is the normal position during ordinary respiration, when the chest is moderately distended with air, and the breathing quiet. It may be about an inch higher on forced expiration, or an inch lower on forced inspiration; this line is the same whether the patient be standing erect or lying upon the back.

While speaking of the liver it will be convenient to complete the description of the hepatic area.

The greater part of the right lobe of the liver is concealed under cover of the ribs on the right side, and part also of the left lobe is beneath the ribs on the left side (*fig.* 10). In the epigastrium part of the right lobe and part of the left are exposed, with the notch, which usually lies almost in the middle line, about half way between the umbilicus and the junction of the sternum with the xiphoid cartilage.

The liver passes under cover of the ribs on the right side just in the nipple line. This corresponds usually with the tip of the eighth costal cartilage.

The **Lower Boundary** of the liver, then, on the right side, is continuous posteriorly with the edges of the costal arch, and comes out from under the ribs in the right nipple line. It then extends across the abdomen in a double curve, interrupted by the notch to the apex of the heart (*fig.* 10).

As the anterior part of the liver overlaps the stomach and transverse colon, the transmitted resonance makes it generally very difficult to ascertain exactly by percussion the lower border of the liver, and it is usually more easily fixed by palpation.

The liver is most conveniently measured in the nipple line. In this line the **Upper Boundary** should be at the level of the upper border of the sixth rib, and **the Lower** should cut the margin of the costal arch. Just outside this part (*i.e.* at the tip of the ninth rib) is the position of the gall-bladder.

The vertical measurement of the hepatic dulness in the nipple line is, in the adult, on the average four inches.

FIG. 11.

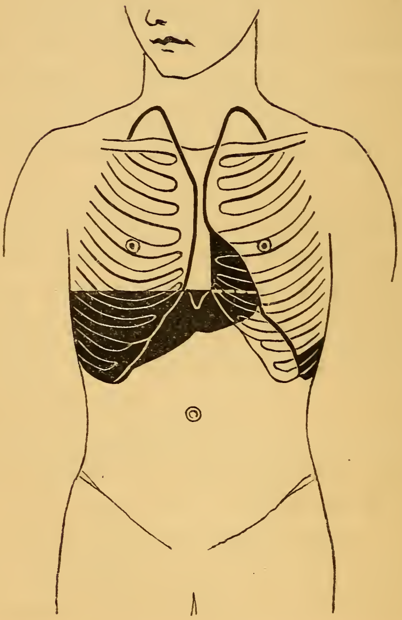


Diagram showing the normal boundaries of the lungs.

The Surface-Markings of the Spleen.

The **Splenic Area** is roughly oval in shape, and dull on percussion. It extends along the tenth rib as its long axis, from the posterior axillary line, forwards and downwards, for about two inches and a half. Its transverse diameter reaches above to the ninth rib, and below to the eleventh rib.

This area cannot, however, always be distinctly made out in adults. It is more easily determined in children. This is due probably to the fact that the ribs are softer and less rigid, and do not, therefore, transmit the resonance so readily from the adjacent lungs.

The Surface-Markings of the Stomach.

The area of **Stomach Resonance** (Traube's zone) extends from the apex of the heart (*i.e.* the edge of the left lobe of the liver) to the tip of the tenth rib.

It is semicircular in shape, the diameter being the edge of the ribs, and measuring about six inches. Its depth is about three inches.

The stomach extends, of course, much farther than this, across the epigastrium, beneath the margin of the liver (*fig.* 10), and, like the colon, which lies in immediate relation with it

below, will give a resonant sound there, but it is only the limited area described above, which, in the examination of the chest, is spoken of as the area of stomach resonance.

The boundaries of the stomach and spleen are not so constant, or so easy to determine, as those of the liver, but they are also not of so much importance, for the liver reaches so far to the left side, that its boundaries, taken in conjunction with the cardiac dulness, are enough to fix, with sufficient accuracy for ordinary purposes, the size of the left lung.

We have now ascertained the position of the diaphragm, and we know, that all that is above this should be occupied by lung, except in the mediastinum, where the heart and great vessels lie. In health we need consider nothing but the heart, for the rest of the mediastinum gives, as the lungs do, a resonant note on percussion.

The Area of Cardiac Dulness is roughly triangular in shape, and corresponds with the space exposed by the left lung as it recedes from the right. It is represented on the diagram, (*q. v*), and will be found fully described later.

The Surface-Markings of the Lungs.

These are as follows:

The Upper. A curved line, the apex of which reaches one inch and a half above the clavicle.

The Anterior.

(*a*) On the **Right Side**, the middle line of the sternum, from the level of the second costal cartilage to the base of the xiphoid cartilage.

(*b*) On the **Left Side**, the middle line of the sternum, from the level of the second to the level of the fourth costal cartilage, and thence to the apex of the heart.

The Lower.

(*a*) On the **Right Side**, the upper border of the liver.

(*b*) On the **Left Side**, a line drawn from the apex of the heart along the upper border of the stomach resonance and the splenic dulness.

The Posterior.

1. A **Vertical Line** drawn on each side one inch from the dorsal spine.

2. A **Horizontal Line** drawn outwards on each side from the eleventh dorsal spine. This, on the right side, is continuous with the upper boundary of the liver.

ALTERATIONS OF BOUNDARIES.

In disease the lungs rarely remain of their normal size. They are either larger or smaller than they ought to be. These changes, though generally evident on inspection and palpation,

Fig. 12.

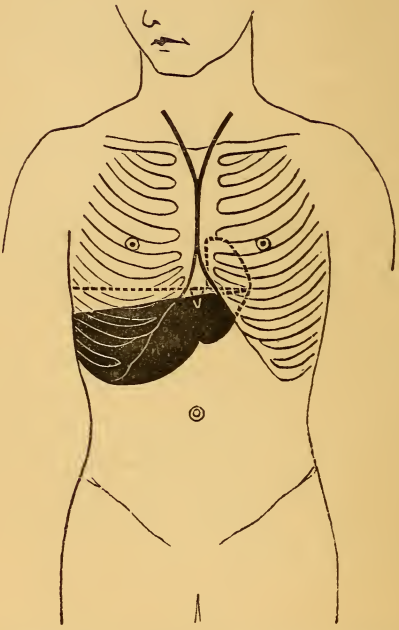


Diagram showing in dark line the actual boundaries of the lungs in a well-marked case of emphysema, and in dotted line the normal boundaries.

are most distinctly indicated by alterations in the boundary lines.

The diaphragm is freer to move than any part of the thoracic walls, and changes in its position are often among the earliest evidences of changes in the lungs. This can be recognised only by percussion. Hence the importance of determining as early as possible in our examination of the chest the position which the diaphragm occupies.

Symmetrical Changes.

Where the lungs are **Symmetrically Enlarged,** as in the disease called emphysema, there may or may not be visible enlargement of the thorax, but there will always be displacement of the diaphragm. The diaphragm will stand lower than it ought, often a whole interspace too low. The cardiac area will also be smaller than it should be; for the lungs, as they enlarge, cover up that part of the præcordium which, in the ordinary condition, is exposed.

The percussion signs, then, of emphysema show displacement downwards of the diaphragm, and diminution in size, or absence of the cardiac dulness.

Where the lungs are **Symmetrically Contracted,** as often happens in old age (senile emphysema),

FIG. 13.

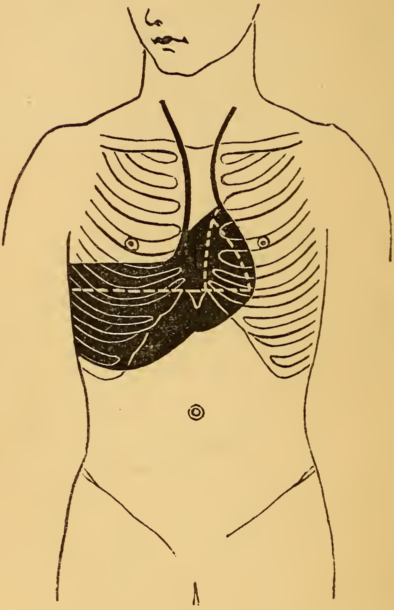


Diagram showing the boundaries of the lungs in a case of bilateral contraction of the lungs (senile emphysema).

The white dotted line shows the normal boundaries.

the diaphragm will stand at a higher level than normal. It may be a whole intercostal space too high, and, in like manner, the præcordium will be more uncovered than usual, and the area of cardiac dulness larger than normal.

Unsymmetrical Changes.

If the changes be limited to one side, the diaphragm on that side will be displaced. If lung on that side be larger, the diaphragm will stand lower, if smaller, it will stand higher.

Where a part of one lung is contracted, as after pleurisy, or where a large cavity has formed in it, the opposite lung, if it has remained healthy, often undergoes compensatory enlargement. This has received the name of **Compensatory Hypertrophy.*** As the one lung is much smaller, and the other much larger, than it ought to be, we shall have evidence of a great dislocation of the boundaries as is shown in *fig*. 14.

A similar extreme dislocation of boundaries is seen in cases where one pleural cavity is greatly distended with air, as in pneumothorax (*fig*. 15),

* This is also spoken of as compensatory emphysema, but, as there is no true emphysema, this term is misleading, and should not be used.

Fig. 14.

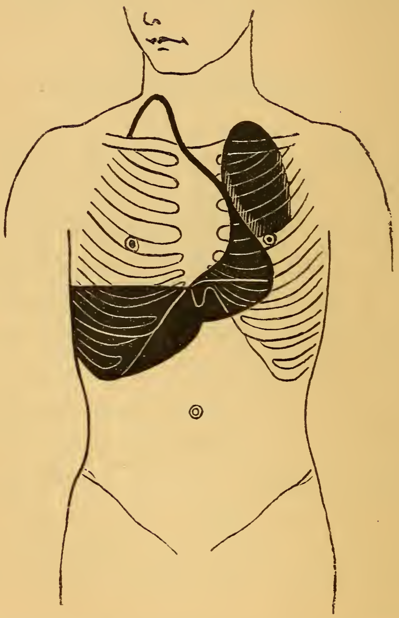


Diagram showing the displacement of the boundaries in a case of contraction of the left lung, with compensatory hypertrophy of the right.

or with fluid, as in pleuritic effusion (*fig.* 16). In these cases, not only is the diaphragm pushed down as far as it can go, so as to become sometimes even concave instead of convex above and to project below the ribs, but the lateral boundaries are also dislocated far over towards the unaffected side.

This we determine by an extension beyond the sternum, in the one case (*pneumothorax*) of the area of resonance, and in the other (*pleuritic effusion*) of the area of dulness.

In cases of pneumothorax, however, in which there is free communication between the air inside the pleura and that outside the body, either by a large opening through the chest-walls or through the lung, and where, consequently, there is no distension of the pleura, *i.e.* no pressure in the pleura, there is still considerable dislocation of boundaries.

This is due to the elasticity of the lungs, the lungs on each side contracting, and that on the sound side dragging over towards itself the mediastinum and the organs in it.

VARIETIES OF PERCUSSION SOUND.

Hitherto we have considered percussion only as the means of determining the size of the lungs,

FIG. 15.

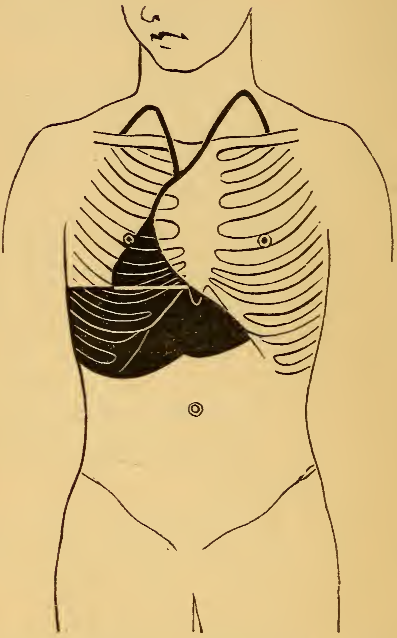


Diagram showing the displacement in a case of pneumothorax of the left side.

we must now consider how it enables us to determine the conditions in which the lungs are.

Wherever the lungs are, the percussion note should be resonant. The amount of resonance will vary within wide limits, even in health, in different individuals. It will depend in great part upon the amount of skin, fat, and muscle which covers the ribs, *i.e.* upon the thickness of the walls of the thorax, and will therefore be less in fat than in thin people. Even in a perfectly healthy chest the resonance varies in different parts, being greatest in the axilla where there is least to interfere with the percussion sound.

But, making allowance for all this, the resonance may be greater or less than it ought to be. In emphysema, where the vesicles of the lungs are dilated and the walls thinned, where, therefore, there is relatively more air and less solid in the lung, the note becomes deeper, more hollow-sounding, more drum-like. This is called **Tympanitic Resonance**, and resembles the note which may be normally obtained on percussing over the stomach.

A variety of tympanitic percussion is not uncommon in cases, where air-containing lung tissue intervenes between the chest-walls and some solid mass more deeply seated, as, for instance, deep-seated pneumonia, or a tumour, or even occasionally fluid effusion in the pleura.

FIG. 16.

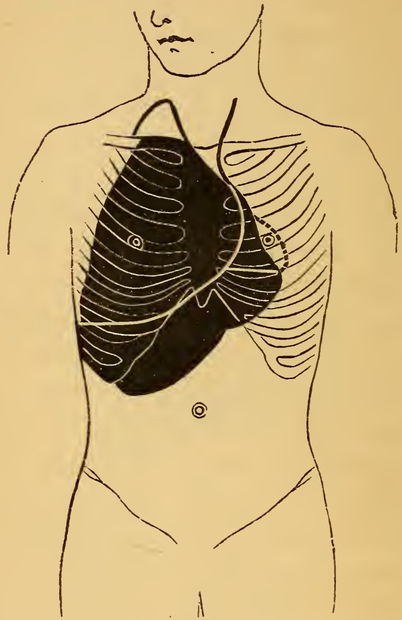


Diagram showing the displacements produced by a large effusion into the right pleural cavity.

The black area represents the absolute dulness of the fluid. The heart is displaced so that the apex is outside the left nipple line. The liver is depressed and twisted, so that the notch is nearly under the margin of the left costal arch instead of being in the middle line.

The white line indicates the probable position of the upper border of the liver on the right side, and of the edge of the right pleura on the left side.

It is probably due to the relaxation of the lung tissue, *i.e.* the loss of its normal tension and tone above the parts diseased.

A similar hyper-resonance is not rare in acute fevers, and has probably the same causation and explanation as that loss of tone in the intestines, which gives rise, under similar conditions, to tympanites.

For the opposite condition, in which there is less air and more solid relatively in the lung, there is no distinctive name, but the percussion resonance is spoken of as **Impaired** or **Deficient.**

Many other varieties of resonance have been described and various names given to them, but they are not really required in actual practice.

For ordinary purposes the following four terms are all that are necessary :

1st. **Tympanitic.**

2nd. **Normal.**

3rd. **Impaired.***

4th. **Dull.**

One other named variety of abnormal percussion sounds must be referred to. This is the **Cracked-pot Sound** (bruit de pot fêlé). This is a

* Boxy is a term often used. The term conveys much what the sound of percussion suggests. It is as though we were percussing an air-containing chamber with dense and rigid walls like a box, and it corresponds frequently with such a condition, pathologically.

jarring or jangling sound, like that produced when a cracked china bowl is struck.

It is not uncommon in cases of phthisis over superficial cavities in the lung, and it is best elicited by forcible, sharp percussion, the patient having the mouth wide open and breathing quietly. It is not constant in phthisis, nor is it by itself any sign of disease of the lungs, for it is not rare in children with healthy chests, and may be produced in adults sometimes, where air-containing lung tissue lies between the chest-walls and some solid mass, either a patch of pneumonic consolidation, a tumour, or occasionally even an enlarged heart.

It is supposed to be due to the sudden forcing out by percussion of a stream of air from a portion of the lung into the bronchial tubes, and can be imitated fairly well by clenching the palms of the hands loosely together, and striking them sharply upon the knee.

Want of Symmetry on Percussion.

Fortunately, it is not for the most part an increase or a decrease in tone, as compared with an ideal typical standard, which we have to recognise, but, as on inspection and palpation, so also on percussion, it is for a want of symmetry, *i.e.* for a difference between corresponding parts on

the two sides, that we look as evidence of disease. If, in symmetrical parts of the chest, the percussion resonance is not also symmetrical, but there is a difference between the two sides, it is certain that some change has occurred in the parts beneath.

The only place in health in which want of symmetry is observed, with the exception of the cardiac area, to which reference has been already made, is at the right apex. There the lung is thicker, stumpier, and is more encroached upon by the large vessels than on the left side. Consequently, there is often a slight impairment of percussion here, as well as also, on palpation and auscultation, a slight increase in the amount of the vibrations of the voice and of the breath sounds.

The difference is, however, slight, and the same amount of difference on the left side would be evidence of disease. It is necessary to refer to this, although it is not likely to create difficulty in ordinary cases.

Wherever the percussion note is unsymmetrical, there is, with the previously mentioned exceptions, some change in the condition of the part beneath, namely, in the lungs or in the pleura.

Under auscultation we shall learn how to determine which of these it is.

For the present it is sufficient to note that by

means of percussion we can establish two sets of most important facts about the lungs.

1. Their extent and their relation to adjacent organs.

2. Their condition, whether healthy or not.

SYNOPSIS.

On percussing a chest, it is most important to proceed systematically.

1st. We must determine the actual boundaries of the lungs, mark them carefully, and compare them with those, which, we know, ought to be found in health.

2nd. We must percuss the symmetrical parts of the chest in order, from above downwards, comparing one side with the other;

I. In front,	1. The supraclavicular regions; 2. The clavicular regions; 3. The subclavicular regions; 4. The mammary and infra-mammary regions;
II. Laterally,	5. The axillary regions;
III. Posteriorly,	6. The suprascapular regions; 7. The infrascapular regions; 8. The interscapular spaces.

If these be all symmetrical, the lungs and pleura are probably healthy. If not, we shall then proceed to ascertain what is wrong by further examination.

AUSCULTATION.

Under this head we place all facts, which we can ascertain by placing the ear upon the chest, and listening to the sounds produced. These are of two kinds.

1. The sounds produced by breathing.
2. The sounds produced by the voice.

Apparatus.

For the purposes of auscultation apparatus is not generally necessary, though it is convenient.

Stethoscopes (stethos the chest, skopein to examine) have been devised of all kinds, some solid, some hollow, and made of metal, wood, ivory, or other substances, of various sizes and shapes. Habit will accustom us to all, and, except for convenience, we might do without any.

The stethoscopes in use at present are of two kinds, the single, for one ear, and the double, for both ears, the binaural.

It is best to commence with the single stethoscope.

The single stethoscope consists of a cylinder,

usually of some tough or light wood, six or eight inches in length, with a broad, flat end on which to place the ear, and a narrow end to be placed upon the chest. It is usually perforated by a hole running from end to end (*fig.* 17).

In chosing a stethoscope the chief points are these :—The broad part should be of such a size and shape that the ear may rest comfortably upon it. The small end should not be more than about three quarters of an inch in diameter. It should have broad, flat, and rounded edges, so that it may not pinch or cut the skin, when it is placed upon it.

Let us suppose, that we are going to examine the chest with the left ear.

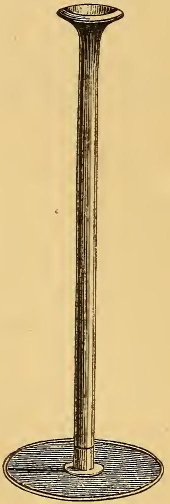
The stethoscope is taken in the right hand near its small end, and placed upon the part we wish to examine, so that this is everywhere close upon the skin, care being taken that nothing is ir contact with the stethoscope or moving upon the walls of the chest. The chest, if possible, should be bare.

The left hand is laid upon the shoulder or back of the patient, and the left ear placed upon the ear-piece of the stethoscope. The right hand may then be taken away, and the stethoscope will be supported between the ear and the chest. No more pressure should be exercised than is required to keep the stethoscope in position.

The hand upon the shoulder will keep the patient steady and will prevent the exercising of more pressure upon the stethoscope with the head, than is necessary to keep it in its place.

In examining a patient, it is most important to be in a comfortable position, otherwise the patient will be probably uncomfortable also.

Fig. 17.

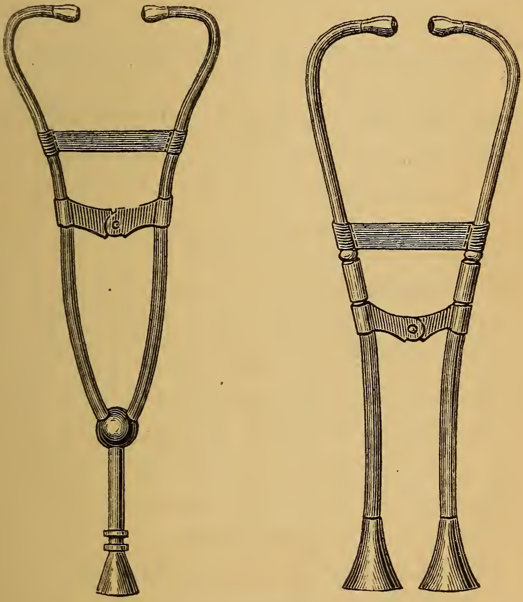


The single stethoscope.

Binaural stethoscopes are now much used (*fig.* 18). They are convenient especially for the examination of patients in bed, but they are not the best to begin with, as it is difficult at first

to distinguish the sounds produced in the stethoscope, from those produced in the lung, and they have this practical disadvantage, that the chest-piece must be placed directly upon the skin, for

Fig. 18.



Binaural stethoscopes.

even a covering of thin gauze is sufficient to interfere greatly with the transmission of the sounds.

The differential stethoscope, in which there are two chest-pieces with separate tubes, is not much

employed at present, and has, I think, no special advantage.

The simplest instrument is the best to begin with, and we shall use the single stethoscope such as is shown in *fig.* 17.

THE AUSCULTATION OF THE VOICE.

We will deal with the voice sounds first, because they are less difficult to explain.

Vocal Resonance.

The vibrations of the voice are produced in the larynx and mouth; the musical note at the vocal cords, the words in the mouth and pharynx. The vibrations are propagated thence in all directions—outwards through the mouth, and backwards along the trachea and bronchial tubes. It is well to select some simple sound for the patient to produce, and to use it constantly, such as the long vowel "ah!" or a repetition of the same sound, as in "ninety-nine."

When now the stethoscope is placed over the larynx, and the patient speaks, we hear the voice-sounds with an intensity which is almost painful. If the stethoscope be placed lower down upon the trachea, we hear them less loudly, and over the

alveoli of the lung, though still audible, they are much diminished in intensity, have lost their clearness and sharpness, and have become humming or muffled.

To the vibrations of the voice which we hear the name **Vocal Resonance** is given, to distinguish them from the vibrations which we feel, and which are called vocal vibrations.

Vocal vibrations we feel (*Palpation*).

Vocal resonance we listen to (*Auscultation*).

Varieties of Vocal Resonance.

The vocal resonance over the vesicles of the lung receive the name of pulmonary, muffled, or, better, **Vesicular** resonance. Over the larynx it is called **Laryngeal**, and over the trachea **Tracheal**, while that which is intermediate between tracheal and vesicular is called **Bronchial**, and bears also the name **Bronchophony** (phone, voice).

These terms are purely conventional and do not admit of accurate definition.

The classification is anatomical, and as the trachea, for example, passes into the bronchi on one side and the larynx on the other, so will the varieties of tracheal resonance pass insensibly into bronchial or laryngeal.

By laryngeal, tracheal, bronchial, and vesicular resonance, therefore, is meant resonance of such a

kind as is heard in health over these parts respectively of the respiratory tract, and, when these terms are used in reference to disease, it is not meant, that we have necessarily an entirely new sound such as is never heard in health, but that sounds, which in health ought only to be heard in particular places, are in disease heard somewhere else, where they ought not to be heard. The sounds of disease are for the most part not so much abnormal sounds, as normal sounds heard in abnormal places.

Fortunately it is not so much the name we give to these sounds, as the fact itself, which is important for the purposes of diagnosis.

If, where we should only hear vesicular resonance, we do not hear it, but some other kind of resonance, whatever name we call it by, we know the lung to be in an abnormal condition.

The vibrations of the voice are carried, not by the walls of the tubes, but by the air within them. This we know to be the case, because, when the column of air is broken by either a foreign body sticking in a bronchus or by the tubes being filled with mucus, we find that the vocal resonance is lost in the corresponding part.

Every time these tubes divide the vibrations are in part dispersed and lost, and where they finally split up into the numerous vesicles of the lungs, this dispersion becomes so great that but

little of the original vibrations is left to pass on to the walls of the chest.

How much the alveolar tissue of the lung is capable of diminishing sound is clearly demonstrated in the case of emphysema, where the enlarged lung comes forward and covers up the heart, muffling the heart sounds* to such an extent as to make them almost inaudible.

Hardly anything can muffle sound better than a pillow, though the actual amount of solid substance it contains is small. The conditions are much the same in the lungs, viz. relatively large air spaces separated from each other by thin, irregular septa (the feathers).

The amount of vocal resonance differs much in different individuals. This depends in chief measure:

1st. Upon the loudness of the voice, *i.e.* the amount of sound produced:

2nd. Upon the depth of the voice, for the deeper the voice is, the coarser are the vibrations; hence in women and children they will be more difficult to hear (as they are also to feel) than in men:

3rd. Upon the thickness of the walls of the

* It is not uncommon under these circumstances for a diagnosis to be made of a weak heart, though the cause of the weak heart-sounds lies not in the heart but in the lungs.

chest. Thus the vibrations are often difficult to detect in very fat people, or where the skin is œdematous, &c.

When the vocal resonance is listened to over a portion of consolidated lung, the vibrations are sometimes carried with unusual distinctness along the stethoscope into the ear, so that not only the vibrations of the voice, but even the words, are very distinctly audible. This is called **Pectoriloquy** or **Direct Vocal Resonance.** It is a variety of bronchophony.

In bronchophony there is an increase in the transmission of the voice or vocal sounds. In pectoriloquy of the speech or articulate sounds.

When the lungs are consolidated, or where there are large cavities in them, the **Heart Sounds**, like the vocal vibrations, are often carried with unusual loudness to the ear, and we speak of them as unduly audible.

In children **The Cry** is as useful as the voice in adults, and the same changes in resonance occur in it.

Often, instead of speaking out loudly, the patient is made to whisper. The **Whisper Sounds** undergo changes similar to those of the vocal sounds. They may be diminished or increased. Thus, we speak of **Bronchial Whisper** or **Whispering Bronchophony**, of **Whispering Pectoriloquy**, and of **Cavernous** or **Amphoric Whisper.**

It has been stated that whisper sounds provide an easy means of distinguishing between an effusion of pus and an effusion of serum into the pleural cavity, the whisper sound being distinct when the effusion is serous, and absent when it is purulent. This is not correct.

When the stethoscope is placed over a part of the chest where the lung is solid, and the observer speaks, the resonance of his own voice is sometimes loudly heard in the ear which rests upon the stethoscope. This has been called **Autophony** (*Autos, own; phone, voice*). Its exact physical causes are not understood, but it is, so far as is known, only met with over consolidated lung.

It remains to speak only of one other term often used, viz. **Ægophony.** This is a peculiar tremulousness, which is added to the vocal vibrations, and which has been compared to the bleating of a goat, whence the name was taken. It is heard in cases of moderate pleuritic effusion at the upper level of the fluid, and usually only posteriorly at the inferior angle of the scapula. Occasionally a somewhat similar tremulousness is heard just above pneumonic consolidation at the base of the lung.

Ægophony is supposed to be due to the irregular conduction of vocal vibrations through lung tissue which is irregularly compressed and

collapsed, as it lies just above the fluid. This sound is of doubtful practical importance.

THE SOUNDS OF BREATHING.

What has been said of the sounds of the voice is true also to a great extent of the sounds of breathing.

If the stethoscope be placed upon the larynx and the patient breathe in and out, sounds will be heard both on inspiration and on expiration. These sounds are produced in great measure like the sounds of the voice by vibrations set up in and round the glottis, and like them they travel in all directions, outwards through the mouth and inwards towards the lungs, and as they travel backwards they will be progressively diminished in intensity, until over the vesicles but little of them is heard.

Now, if we compare the breathing over the larynx with that over the vesicles, we shall notice that not only is there a difference in loudness, but that there is also an alteration in character.

The Sounds at the Larynx are clear, harsh, and double; both inspiration and expiration are loud, and equal in loudness and duration.

Over the Vesicles the sound is feebler and has

lost its clear character. It has become, like the voice sounds, muffled, and instead of two sounds one only is audible. Expiration is absent, or if not entirely absent, is only to be heard faintly and with difficulty.

As in the case of the voice sounds so with the breathing sounds a classification can be made into

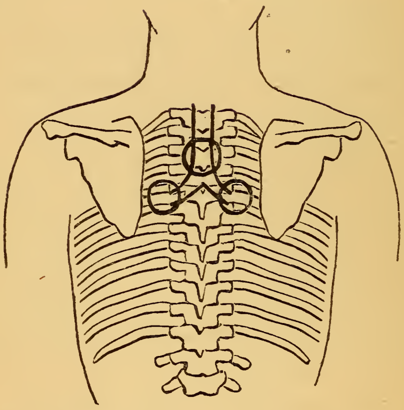
Laryngeal.
Tracheal.
Bronchial.
Tubular.
Vesicular.

Again, this is a purely anatomical classification, and we mean by these terms, when we are speaking of disease, that the respiratory sounds audible resemble those heard in health either in the larynx, trachea, bronchi, smaller tubes, or vesicles.

If we are in doubt what name to give to a particular kind of breathing we should compare it with that heard over different parts of the respiratory tract, and give it the name of that part to which it bears the greatest resemblance.

Stridor is a peculiar variety of laryngeal or tracheal breathing. It is pathognomonic of narrowing or constriction of some part of these tubes. It is a loud, harsh, see-saw, double

FIG. 19.



Shows the position of the trachea and bronchi behind.

The circles mark the spots where bronchial breathing is often heard in a healthy chest.

grating sound, audible at a distance from the patient and associated usually with dyspnœa. The cough in these cases is also usually croupy, or as it is called brassy. The constriction is most commonly produced by the direct pressure upon the trachea of an aneurysm or tumour, but it may have its seat in the larynx in consequence of local changes there, as in croup in children, or in stenosis or tumour in the adult.

The larynx and trachea are superficial but the bronchi are deeply placed. Bronchial breathing may sometimes be heard normally in front under the first piece of the sternum, and behind either upon the second dorsal spine or right and left of the spine an inch or two lower in the interscapular spaces (*fig.* 19).

Vesicular breathing is soft and muffled in character, and consists almost entirely of an inspiratory sound, expiration being either quite inaudible, or very faint.

The sound is made up of two parts.

1. The sound which is conducted along the bronchi and smaller tubes and modified by having to pass through the vesicles.

2. A sound produced in the vesicles by the air as it passes into them from the small air tubes.

Whatever explanation is given of its production, the sound itself is characteristic.

What it is, however, cannot be taught by description. It must be learnt by observation.

Vesicular breathing is, as has been said, marked off from all other kinds by the absence or great enfeeblement of the expiratory sound. If this be faintly audible, we approach the kind to which the name tubular is given. If it be as loud and long as inspiration and have a high harsh pitch, such as we hear occasionally over the bronchi at the places named, we should call it bronchial.

In bronchial breathing the sound resembles that produced by the mouth when placed in the position to pronounce the guttural "ch."

In tracheal breathing the sounds, both of expiration and inspiration, approach more nearly "ah," and in laryngeal "au."

Cavernous and **amphoric** breathing are not audible anywhere in health. They approximate in character to the laryngeal sound, but have in addition a greater hollowness, and, in the case of amphoric breathing, certain superadded semi-musical (consonant) sounds, such as those heard on breathing into a jug (*amphora*), from which the name is taken.

Sometimes the breathing sounds over the vesicles are normal, so far as their character goes, *i.e.* they are vesicular, but their rhythm is

altered. They have become **jerky, interrupted** (Saccadée), **wavy.**

The cause of this alteration of rhythm may vary.

It may be due to irregular action of the muscles, either in consequence of some change or defect in the muscle itself, or, as is more common, in consequence of irregular nervous action. Hence it is very common in nervous and hysterical patients.

Or its cause may lie in the lung itself, and be due to imperfect and irregular expansion of the lung tissue. Hence it is often met with in the early stages of consolidation of the lung.

Such alterations in the rhythm of respiration are usually unsymmetrical and are to be distinguished from those symmetrical abnormalities which are due to irregular respiratory movements as in sobbing, sighing, coughing, &c., in which the whole rhythm may be much altered, through the action of the nerve centres as in Cheyne-Stokes breathing (*q.v.*).

Variations in the breathing sounds depend upon the same conditions as those of the voice sounds.

Energetic breathing increases the loudness, and if it be violent, we often get over the vesicles both inspiration and expiration audible. This has received the name of "**puerile breathing,**"

because it is so commonly heard in children, even with perfectly healthy chests. It corresponds very closely with the tubular breathing previously described.

By some authors bronchial is used as a general term, to mean simply that the breathing sounds are altered from health, and are exaggerated or increased. This double use of the term produces great confusion. Bronchial is by most writers used in its anatomical signification as it has been here described, to signify a particular kind of altered breathing which is very characteristic.

This is the only reasonable use of the term. If the mere fact that the breathing sounds are altered or exaggerated has to be expressed without specifying in what particular respect, for the sake of clearness it is best to say so simply, and to use the term "altered" or "exaggerated," which states general facts and leads to no misunderstanding.

It is quite unnecessary to construct minute definitions of the various terms used. The only intelligible interpretation is the anatomical one, and it would be well to agree to use the terms only in this sense, recognising that as the parts of the respiratory tract pass without distinct limitation into one another, so, too, will the varieties of respiratory sounds.

It is good, however, to retain these separate

terms as indicating roughly the amount and kind of change which the lung has undergone.

USE OF THESE FACTS IN DIAGNOSIS.

Let us inquire now what use we can make of these facts for the purpose of diagnosis.

The sounds produced at the larynx, whether by the voice or by breathing, are transmitted, as we have said, almost entirely by the air column in the trachea, bronchi, and smaller tubes to the vesicles of the lungs. They then cross the two layers of the pleura to reach the chest walls, and through these are conducted to the ear.

Along their whole course they are progressively diminished;

1st. Every time that the air-tubes divide, and especially by their terminal expansion into the vesicles;

2ndly. As the vibrations pass from the vesicles to the pleura and chest walls, and thence along the stethoscope to the ear.

We may regard all these parts, viz. the air-vesicles, the pleura, and the chest walls as so many obstructions placed in the way of the vibrations.

Any alteration in these parts will change the transmissibility of the vibrations. It may make them more easily or less easily heard, and we

shall speak then of the voice or breathing sounds,

1. As **Increased**, *i.e.* more intense than normal,
2. As **Diminished**, } *i. e.* less intense than normal,
3. As entirely **absent**, }

And lastly, as **Modified** (*e.g.* in ægophony).

If, for instance, the walls be very thick, as in fat persons, or where the subcutaneous tissue is œdematous, a greater obstruction will be offered to the vibrations, and they will be diminished.

If we lay outside the walls of the chest several folds of cloth, we place a fresh obstruction in the way of the vibrations, and they are therefore diminished.

If we take a water cushion and lay it upon the chest, the vibrations then cease to be audible, and become completely absent. The effect would be the same, if we could place the water cushion inside the chest walls, *i.e.* in the pleural cavity.

In many forms of disease of the pleura this is exactly the condition which is produced. An effusion of fluid takes place into the pleural sac, and we have our water-bag inside the chest.

In other cases the pleura itself becomes much thickened, but in both cases alike a fresh obstruction is offered to the passage of vibrations, and they will be either much diminished or completely absent.

On the other hand, we have learnt that it is the

breaking up of the air-tubes into the vesicles of the lung which muffles most the vibrations in health, for they have to pass through a most heterogeneous body formed of numerous irregular air-chambers separated by thin septa, like a feather pillow.

Suppose now, that this very heterogeneous body were made homogeneous by the substitution for the air in the vesicles of some solid substance, we should do away at once with what we know to be one of the chief obstructions to the passage of vibrations. The other parts then remaining the same, the vibrations would reach the chest walls increased in intensity.

This we find to be the case, and we have therefore an easy means of diagnosing between diseases of the two great structures belonging to the lung, viz. the lung itself and its pleural sac, for we have, **in affections of the pleura** one obstruction more, and therefore diminished passage of vibration, and **in solidified lung** one obstruction less, and therefore increased transmission of vibrations.

All that has been just said applies equally to the vocal resonance, the vocal vibrations, and the breathing sounds.

If, then, we find in any part of the chest that the vocal vibrations, the vocal resonance, and the breathing sounds are increased, we may con-

clude that this is due to the lung in that part having become consolidated. If, on the other hand, we find the vocal vibrations, vocal resonance, and the breathing sounds diminished, we may infer that the pleura is affected. In both cases alike percussion will be either much impaired or absolutely dull, because there is either but little air containing lung tissue or none at all in that part.

Given then a part of the lung in which the percussion is impaired or dull, we are enabled by palpation and auscultation to determine, whether this dulness be due to an affection of the lung or of the pleura according to the following table :

Table for the diagnosis between Disease of the Pleura and Disease of the Lung.

Disease of the Pleura (e.g. *fluid effusion*). Percussion dull.		**Disease of the Lung** (e.g. *pneumonic consolidation*). Percussion dull.	
Vocal vibrations Vocal resonance Breathing sounds	diminished or absent.	Vocal vibrations Vocal resonance Breathing sounds	increased.

As has been already stated the vibrations travel chiefly by the air in the tubes. If, then, by any chance the tubes become plugged, so that the continuity of the column of air is broken, the transmission of the vibrations will be prevented. This happens occasionally in pneumonic consoli-

dation where there is excessive secretion, and makes the diagnosis difficult; but the course of the case will remove all doubt. For, as the secretion is removed, the ordinary signs of consolidation will appear.

NEW SOUNDS.

We have hitherto spoken of sounds, the analogues of which may be heard normally in health. We come now to the class of sounds, which are heard only in disease. These fall into two groups,

1. Those produced in the lungs, **Pulmonary.**
2. Those produced in the pleura, **Pleural.**

To the pulmonary sounds the name **Râles** was given by Laennec, who divided them into crepitant, mucous, and sonoro-sibilant; the two first are more commonly called **Crepitation**, and the latter **Rhonchus** and **Sibilus.**

These are the terms which we shall employ.

Crepitation.

Crepitation is produced by the bursting of air-bubbles in fluid, and it is spoken of as **Large**, **Medium**, or **Small**, according to the supposed size of the bubbles which produce it, the larger bubbles giving rise to the louder sound.

Excellent crepitation is heard after washing the hands in warm water, as the little soap-bubbles, which form the lather, burst. This explanation has caused crepitation to be often spoken of as **Moist sounds**, in contradistinction to **Rhonchus Sibilus**, and which are called **Dry sounds.**

One form of crepitation has probably a different explanation from that given above. This is called **Fine Hair Crepitation**, because it sounds like the crackling of the hair of the head or whisker when rubbed between the fingers over the ear.

It is probably due to the crackling produced by the separation of the walls of the vesicles from each other by inspiration, when, as the result of collapse or pressure, they have been in partial contact.

Crepitation similar in character, though probably not produced in the same way, is also heard occasionally over emphysematous lungs.

The noisy bubbling sounds, which are heard in the trachea of dying people, and to which the name of the "**The Death Rattle**" is given, are produced, like the ordinary forms of crepitation, by the bubbling of air, as it passes through the mucus which has collected in the trachea.

Rhonchus and Sibilus.

Rhonchus and **Sibilus** are sounds often musical in character, produced by vibrations set up in

the air, as it passes through the bronchial tubes, the mucous membrane of which has been altered or roughened by inflammation or secretion.

Rhonchus is produced in the large tubes and is deeper in tone. It is often described as snoring, cooing, or grating, according to the special characters of the sound.

Sibilus is produced in the small tubes, and is wheezing and more hissing in character.

One great peculiarity of rhonchus and sibilus is the rapid way in which they alter or occasionally temporarily disappear, as the mucus which has caused them is dislodged. A fit of coughing will often alter the character of the rhonchus and sibilus, as well as also the places where they are heard.

Coughing affects also crepitation, occasionally removing it, when we may infer that it was produced by a temporary accumulation of mucus in a small bronchus, or, as is usual, rendering it more evident, and sometimes producing it, where in ordinary respiration it is not audible. In every case, where it is at all likely that crepitation may be produced, the patient should be made to cough, while the chest is being examined and then, either during the cough or, as is more common, during the deep inspiration which follows it, crepitation may be heard.

Pleural Friction.

The surfaces of the healthy pleura are smooth, and move upon each other during respiration without producing any sound. When the surfaces are no longer smooth, but are roughened by disease, the rubbing of the two rough surfaces produces a sound, to which the name of **Friction** is given.

The character of pleural friction differs much in different cases. Sometimes it resembles the creaking of a piece of dry leather when it is folded. This is called **Dry-Leather Creaking.** At other times it is distinctly rubbing in character.

At other times the sound is hardly a rubbing sound, so much as a minute crackling, audible usually at the end of inspiration.

This it is often very difficult to distinguish by the sound alone from the fine small crepitation produced in the lung.

Characters of the Friction Sound.

Friction, being produced in the pleura near to the surface, will sound "*close under the ear*"; as the lungs move to and fro, it will be "*double*"; being due to the roughening of the pleura, it will be heard only where the roughening exists,

and may therefore be very "*limited in extent*"; and being produced by the movements of the lungs during respiration, it will "*cease when the breath is held.*"

Where the pleura is roughened immediately over the pericardium, the movements of the heart may be sufficient to produce the rubbing. This is called **Pleuro-Pericardial Friction.** When as sometimes happens, this is not modified by breathing, it will be difficult to distinguish from the friction sound, produced by a similar roughening of the pericardium (*cf. pericardial friction*).

In inflammation of the pleura, so soon as the part becomes roughened, a friction sound is produced. Soon the two layers are separated by an exudation of fluid, and the sound then disappears. When the inflammation subsides, and the fluid is reabsorbed, the two layers come once more into contact, and the friction sound is heard again. This is called **Redux Friction,** because it has come back.

The same may occur with crepitation in some cases, and then it is spoken of in like manner as **Redux Crepitation.**

When from some cause air gets into the pleural cavity, the case becomes one of **Pneumothorax** (*air in the thorax*). The lung then collapses away from the chest walls back to the spine round its roots, *i.e.* the bronchus and

great vessels. As in the case of an effusion of fluid, the lung is separated a long distance from the walls of the chest, though by air instead of fluid, and the voice and breathing sounds have to pass through a large air-containing chamber, before they reach the ribs. In most cases this has the same effect, as if the effusion were not air but fluid, and the vocal vibrations, the vocal resonance, and breathing sounds are either much diminished or absent.

It might have been expected, that the air cavity would act like a sounding box, and increase these sounds, and in some instances this does occur, but only when there is a large opening from the lung into the cavity, providing free communication with the large bronchi. The sounds, which are produced in them, are then transmitted to the cavity, and become altered by consonance, so as to be more or less distinctly amphoric. Not only may the breathing and voice sounds become amphoric under these circumstances, but also crepitation. It has then received the name of **Metallic Crepitation.**

Metallic Tinkling has a different explanation. It is caused by drops of fluid falling from the walls of a cavity into fluid below (*gutta cadens*), giving rise to the same sound as drops of water often do, when falling in a well or grotto.

When, over a pneumothorax, a coin is laid upon the chest walls, and tapped lightly with another, while the ear is placed upon the chest, the sound is often heard like the tapping of a metal bell or a porcelain dish. To this has been given the name of **Bell Sound** (*bruit d'airain*).

It may be audible over any sufficiently large cavity. It is most common, though not constant, in pneumothorax, and in some of these cases ordinary percussion may be similarly metallic.

When air has been for some time in the pleura, it is generally associated with an effusion of fluid, usually pus, but occasionally serum, and the names of **Pyopneumothorax** (*air and pus in the pleura*), and **Hydropneumothorax** (*serous fluid and air in the pleura*) are given respectively.

This mixture of fluid and air in a large cavity gives rise to a new physical sign, which can only be met with under these conditions (*air and fluid*), and which is therefore said to be "pathognomonic." This is **Succussion**, a splashing sound, heard when the patient is suddenly shaken, while the ear is resting upon the chest, though it may sometimes be heard at a distance from the patient.

Succussion may also be produced in the stomach, a fact which must be borne in mind in diagnosing pneumothorax of the left side, though it can rarely cause any real difficulty.

Theoretically all these sounds, amphoric and succussion, may be produced quite as well in a large cavity in the lung as in pneumothorax, although the cases are in practice rare, in which any confusion might arise.

When, however, the opening into the lung is wide, the physical conditions are almost identical, and the diagnosis becomes very difficult from auscultatory signs alone.

SYNOPSIS.

On auscultating the chest we must proceed systematically. We must listen:

1. To the **Voice Sounds**, and determine whether they are symmetrical, *i.e.* whether they are equal on the two sides; if there be a difference we must note it, and ascertain whether it be an increase on one side, or a diminution on the other:

2. To the **Breathing Sounds**, and ascertain if they be symmetrical or not; we must listen, first, for the **Inspiratory Sound**, and next for the **Expiratory Sound**; if expiration be audible, we must note its length, duration, and intensity in comparison with inspiration, and may express the changes by the use of such terms as tubular, bronchial, &c.:

3. We must listen for **Superadded Sounds**, such as are never audible in a healthy chest, for **Crepitation, Friction**, or sounds characteristic of large cavities, such as **Amphoric** or **Cavernous Sounds, Metallic Echo** and **Tinkling, the Bell Sound**, or **Succussion.**

CONCLUSION.

The detection of the early stages of disease of the lungs is often very difficult, and would be impossible without careful attention to minute details.

The normal variations in the physical signs of the chest are so wide, and the transition between health and disease so gradual, that no sharp line of demarcation can be drawn between them. It is upon a want of symmetry in these physical signs that we chiefly rely. Most diseases of the lungs are unsymmetrical, either only one side is attacked, or if both sides are attacked, they are rarely affected to the same degree. So that the physical signs can hardly ever be symmetrical, and whether we inspect, palpate, percuss, or auscult, in all cases alike, it is for this want of symmetry that we are on the watch.

In one place only (with the exception of the cardiac area) is there normally any want of symmetry. This is at the right apex. There, for the reasons already mentioned, percussion is hardly so resonant, while the vocal vibrations, the vocal resonance and breathing sounds are slightly more intense, than on the left side. The difference is

only slight, and the same difference against the left side instead of the right would be evidence of disease.

Lastly, a diagnosis should never be based upon a single physical sign. An abnormality in one respect alone may be physiological. In disease of the lungs there will certainly be a concurrence of several physical signs, which separately might be worth little, but which taken together make the diagnosis certain.

It is desirable, so far as possible, to represent all the facts observed in a diagrammatic form.

Dulness may be represented by shading (or colouring) the corresponding parts of a diagram of the chest. Vertical lines may be used to indicate that the dulness is due to solid lung, horizontal that it is due to fluid.

Crepitation may be represented by dots or small circles according to the size (large, medium, or small).

Cavities by irregular areas, described in the shaded parts.

Pleuritic Friction by zig-zag lines.

Other physical signs by initial letters.

Fl. = Flattening.
Mts. = Movements.
V. V. = Vocal vibrations.
V. R. = Vocal resonance.
Rh. = Rhonchus.

Sb. = Sibilus.

Pect. = Pectoriloquy.

Æg. = Ægophony.

I. = Inspiration.

E. = Expiration.

R. = Respiration.

R. v. = Vesicular.

R. t. = Tubular.

R. br. = Bronchial. Respiration.

Rtr. = Tracheal.

R. c. = Cavernous.

R+. = Prolonged respiration.

R—. = Deficient respiration.

I. = < > E. = Inspiration equal to, shorter, or longer than expiration.

SYNOPSIS OF THE EXAMINATION OF THE LUNGS.

In the accompanying table I have given the chief subdivisions of the examination of the lungs; the details are given in the text, and are summarised at the end of each chapter.

Inspection.

The chest at rest. **The shape.**

The chest in motion. **The movements** of respiration.

Palpation.

The **vocal vibrations.**

The **sense of resistance.**

Abnormal sensations (friction, &c.).

Percussion.

The **normal boundaries** of the lungs.

The **resonance** of the various parts of the chest.

Auscultation.

The **vocal resonance.**

The **breathing sounds.**

Superadded sounds.

SECTION II.

THE HEART.

THE EXAMINATION OF THE HEART.

The examination of the heart is conducted upon the same system as that of the lungs.

We consider:

First—What we can see **(Inspection).**

Secondly—What we can feel **(Palpation).**

And lastly—What we can hear **(Percussion and Auscultation).**

INSPECTION.

That part of the thorax which is over the heart is called the **Præcordium** or the præcordial region.

On Inspection we consider

First—its **shape**;

Secondly—the **movements** visible there.

THE SHAPE.

In health, there is nothing in the shape of the præcordium to indicate the position of the heart, and even in many forms of disease there is no perceptible change in it.

Where, however, the heart is very large, especially in young people, the præcordium may be unduly prominent, and it is then said to be **Bulging**.

THE MOVEMENTS.

When the heart is healthy, the only movement visible under ordinary circumstances is that of

the apex. This movement is seen in the fifth intercostal space, one inch inside, and usually about one inch and a half below, the left nipple.

Measurements, however, taken with the nipple as a fixed point are unsatisfactory, because the nipple is not always found in exactly the same place. For this reason it is better to take instead of the nipple **The Nipple Line.** This is a line drawn from the middle point of the clavicle vertically downwards. It passes usually through the nipple.

Position of the Apex.

The Apex then is seen in the fifth intercostal space, one inch inside this line on the left side.

In health, it is identical with the true anatomical apex of the heart, but, in disease, this is often not the case, and the impulse which we see frequently corresponds with a part of the left ventricle some distance from the anatomical apex.

When we speak therefore "*clinically*" of the apex, we agree to mean that point on the left hand side of the chest furthest outwards and downwards, at which the movement of the heart can be seen or felt. This is often two or three inches from the normal place.

Normal Peculiarities of the Apex.

In children, the apex is often normally slightly higher and farther out than in adults, and may beat in the fourth interspace or under the nipple.

In adults, when lying over on the left side the apex is often seen in the nipple line. Hence in fixing the apex, the patient must either stand erect, or, if lying down, must lie straight upon the back.

The contraction of the abdominal muscles on standing up counteracts the tendency of the heart to fall, so that the apex is not displaced. The same occurs in the case of the liver, the upper border of which is if anything, a little higher when a person is standing up, than when he is lying down.

Respiration makes no perceptible difference in the position of the apex.

Displacement of the Apex.

When the apex is not in its normal place, it is said to be **Displaced** or dislocated.

Even a very slight displacement may be of great importance, for there is hardly any disease of the heart or pericardium, in which the apex preserves its normal position.

Thus, in disease of the mitral valve, and in all cases of enlargement of the right side of the heart, the apex is displaced outwards (*i.e.*, to the left side) but it still remains in the fifth space. In disease of the aortic valves and in all cases of enlargement of the left ventricle, the apex is displaced not only outwards but also downwards, and is often found in the sixth or even the seventh space.

In pericarditis, the apex is often raised, so as to beat in the fourth space. This is especially the case in children.

Where the heart is displaced, the apex will of course be displaced also.

This may happen in one or two ways, either by the heart being pushed out of its place, as, for instance, by the pressure of air or fluid in the pleural cavity, or by its being pulled out of its place, by the contraction of some part of the chest in relation with it. Which of these causes the dislocation is due to, must be determined by further examination.

In some rare cases all the organs are placed upon the wrong side, *e.g.*, the heart on the right and the liver on the left. This is spoken of as **Transposition of Viscera.** It is a very rare condition.

The Character of the Apex Beat.

In health, this is a simple slight bulging, due to the contraction of the ventricles, affecting a circle of about half an inch in diameter, such as we might expect to produce by tapping with one finger on the inside of the intercostal space.

In disease, the apex beat is frequently altered in character.

When it is visible over a much larger area than normal, it is described as **Extended Cardiac Impulse.**

When it is not distinctly localised, it is spoken of as **Diffused Impulse.**

When it is not a simple bulging, but has a wave-like movement, it is called **Undulatory Impulse.**

When the intercostal space corresponding with the apex is drawn in, instead of bulging, each time the heart contracts, this alteration is described as **Systolic Recession** of the apex.

Systolic recession is occasionally seen in the second, third or fourth spaces, but only when the patient is very thin, and is commonly associated with some contraction of the upper part of the left lung.

Occasionally an impulse is seen at the apex, not only when the heart contracts, but also when it commences to dilate. This is called

"**Diastolic Impulse**" (or the back stroke of Hope).

Pulsation in Abnormal Places.

In disease, impulse synchronous with the movements of the heart is often seen at other parts of the chest beside the apex;

1. Below the xiphoid cartilage in the epigastrium; this is called **Epigastric Pulsation**:*

2. In the second intercostal space, right and left of the sternum, in relation with the aorta on the right side, and with the pulmonary artery on the left; this commonly occurs in cases in which the lungs are contracted at the apices:

3. Occasionally on the right side in the fourth or fifth intercostal spaces, even as far as the right nipple; this is due to displacement of the heart, but it is not the apex which beats here, for it is not a part of the left ventricle but of the right:

4. Under the manubrium sterni; this is generally due to disease of the great vessels (aneurysm):

5. In the vessels of the neck, either in the arteries (*arterial pulsation*), or in the veins (*venous pulsation*).

* Pulsation is occasionally observed in the hepatic region, below the lower ribs on the right side. This usually is associated with heart disease, and is called **Hepatic Pulsation.**

Arterial Pulsation is systolic, and due to the very forcible projection of blood into the vessels.

Venous Pulsation is usually systolic, but may be also diastolic.

When the beating of the heart is very forcible, the whole præcordium is often lifted by it. This is known as **General Heaving.**

SYNOPSIS.

On inspection then we look for

1st. Changes in **the Shape of the Præcordium.**

Bulging;

2nd. Changes in **the Movements,**

I. **At the Apex,**

(*a*) Change in its position,

(*b*) Change in its character,

Increased,
Extended,
Diffuse,
Undulatory,
Diastolic impulse,
Systolic recession;

II. **In other Places,**

General heaving,
Epigastric pulsation,
Pulsation over the aortic or pulmonary valves,
Pulsation in other parts of thorax, (Aneurysmal).
Pulsation in sides of neck,

(*a*) Venous.
(*b*) Arterial.

Pulsation in the hepatic region.

PALPATION.

As in the case of the examination of the lungs, speaking generally, all that can be seen can be also felt, both as regards the shape of the præcordium and the movements of the heart.

The movements are often more easily recognised by the hand than by the eye, and the position of the apex is always finally fixed by palpation.

To Fix the Apex.

This should be done with the tip of one finger, the object being to find out the exact point farthest outwards and downwards, at which the heart can be felt beating.

Abnormal Sensations.

Next the whole hand should be placed upon the præcordium, first below and then above, in order to detect either undue movement in this region, or abnormal sensations such as do not occur when the heart is healthy.

The most peculiar of these abnormal sensations are described as **Thrills.** They are due to coarse vibrations, set up by eddy-like currents in the blood, in consequence usually of some obstruction to the course of its current.

Thrills may be systolic or diastolic, *i.e.* may occur, when the ventricle is contracting or dilating.

Of all thrills the most striking occurs at the apex, and has been aptly compared to the sensation felt when the hand is placed upon the back of a cat purring, and from this it has received the name of **Purring Tremor**, or **Fremissement Cataire.** It occurs immediately before the contraction of the ventricle, and is therefore called præsystolic.

Similar thrills are occasionally felt in the second or third intercostal spaces on the right or left side. They are most common on the right side, and are connected with affections of the aortic valves. Occasionally the vibrations occur at such regular intervals as to produce a musical note. To this reference will be made again under auscultation.

When the two layers of the pericardium are roughened, the rubbing of the two surfaces together may be easily heard, but it is sometimes also felt. It is called **Pericardial Friction** or **Friction Rub.**

Thrills, as well as also friction, are sometimes felt under the manubrium sterni. In these cases

they are due usually to aneurism of the arch of the aorta.

In the neck, thrills are occasionally felt both in the arteries and veins. In the arteries, they are usually propagated from some point below, generally from the aortic valves. In the veins, they are commonest in cases of extreme anæmia, *e.g.* chlorosis.

When the valves of the pulmonary artery close forcibly in thin people, their closure may be frequently felt by the hand as a sharp flap or shock in the second left intercostal space. This is often visible, as well as to be felt, and has already been referred to under Inspection. It has received the name of **Valve Shock** (Klappenstosz).

SYNOPSIS.

Palpation enables us to confirm most of the facts recognised on inspection, and further to ascertain the occurrence

1. Of **Thrills**,
    (*a*) Systolic,
    (*b*) Diastolic,
    (*c*) Presystolic;
2. Of **Valve Shock**;
3. Of **Friction.**

PERCUSSION.

The Size of the Heart.

How Large is the Heart? As with the lungs, so with the heart, this is naturally the first important question, and it can only be answered by means of percussion.

It has been already stated, that part of the heart is uncovered by the left lung, and that this part lies just above the diaphragm to the left of the middle line of the sternum (*fig.* 20). If we percuss this part we obtain a non-resonant sound, for the reason that there is no air-containing lung beneath.

The **Cardiac Area** is, roughly speaking, a triangular space. To describe a triangle three points are required, and these three points are:

1. The apex, which is to be found in the fifth intercostal space one inch inside the left nipple line;

2. The junction of the fourth left costal cartilage with the sternum;

3. The bottom of the sternum at its junction with the xiphoid cartilage.

FIG. 20.

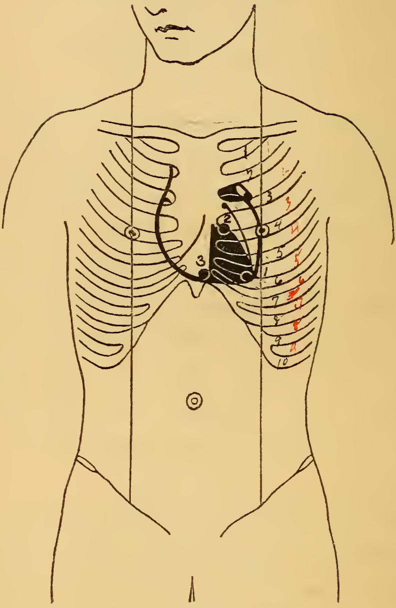


Diagram showing the real size of the heart, and the size of the absolute cardiac dulness.

1, 2, 3, are the three points described in the text.

The area of cardiac dulness may be then described by drawing

1. One line (**the Upper Boundary**) slightly curved outwards from the apex to the junction of the fourth costal cartilage with the sternum on the left side;

2. A second (**the Lower Boundary**) from the apex to the base of the xiphoid cartilage; this is nearly horizontal;

3. A third (**the Right Boundary**) from the base of the xiphoid cartilage vertically upwards along the left border of the sternum to the fourth costal cartilage.

Within this area the percussion sound will be dull, or, if not absolutely dull, will be much impaired. This area is called the area of **Absolute —or Superficial—Cardiac Dulness.** It does not, of course, represent the real size of the heart, which we know occupies a much larger space in the thorax (*fig.* 20). If we percuss forcibly outside the upper boundary, we obtain a note, which, though more resonant than within the area described, is still less resonant than the note in other parts of the chest, for by forcible percussion we throw into vibration the deeper parts of the chest, and these are, of course, less resonant where the heart is, than where there is nothing but lung tissue. This increased area of impaired resonance is called the **Deep—or Rela-**

tive—**Cardiac Dulness.** It extends about three quarters of an inch beyond the upper border of the area of absolute dulness along the fourth rib, and curves down to fuse with it at the apex (*fig.* 20).

The Lower Boundary cannot be determined by percussion, for the heart lies here upon the diaphragm, and the diaphragm upon the liver, and both the heart and the liver give a dull note to percussion. This boundary may be, however, accurately represented by drawing a horizontal line from the apex of the heart to the base of the xiphoid cartilage. This line is in direct continuation with the upper border of the area of hepatic dulness described previously.

The right border of the heart cannot be shown by percussion to extend beyond the left edge of the sternum, and for this reason. The sternum is a solid body, lying above and to the right side immediately upon the lungs. When it is percussed we obtain vibrations, not only from the parts immediately beneath, but also by conduction from the lungs in relation with it at a distance from the part percussed, and the sound is then resonant, even on parts of the sternum under which no lung lies.

When from any cause, as for instance by enlargement of the right side of the heart, the lung is pushed away from the sternum, the

resonance over it will become impaired, or even absolutely dull.

If the lungs and the pleura are normal, any increase in the size of the heart is attended by a correlative increase in the size of the cardiac dulness, but, if the lungs and pleura be not healthy, a difficulty may arise in one of three ways.

1. If the lungs be too large, as in emphysema, they will encroach upon the cardiac area, and cover up the heart, either wholly or in part, and the cardiac dulness will then be either wholly absent, or be much reduced in size (*fig* 12).

2. If the lungs be contracted, as they often are in chronic affections, more of the heart will be exposed, and the cardiac dulness will be proportionately increased (*fig.* 13).

3. Lastly, if the lungs be consolidated, or the pleura be diseased, in those parts which are in immediate relation with the heart, we shall obtain on percussion a dull note, as over the heart itself, and our means of determining the heart's dulness will be lost.

Alterations in the Cardiac Dulness.

Diseases of the heart, in almost every case except atrophy,—and this cannot be clinically demonstrated—are attended by increase in its

FIG. 21.

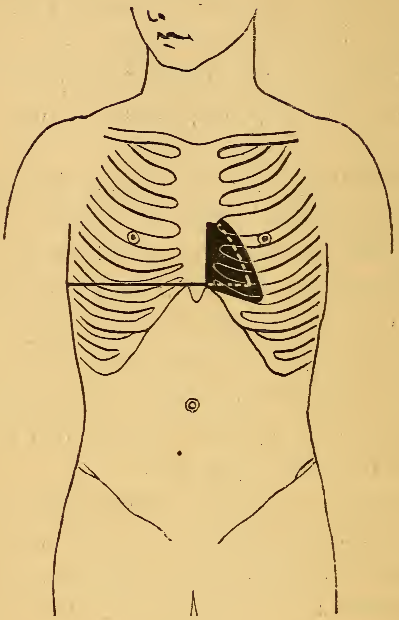


Diagram showing the shape of the absolute cardiac dulness in aortic disease (enlargement of the left ventricle).

Apex displaced downwards and outwards. The white dotted line shows the normal area of absolute cardiac dulness.

FIG. 22.

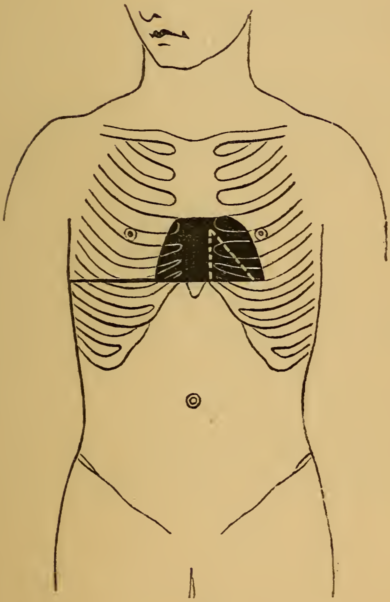


Diagram showing the shape of the absolute cardiac dulness in mitral disease (enlargement of the left auricle and of the right side of the heart).

Apex displaced outwards and not downwards. Great increase of dulness to the right.

The white dotted line shows the normal area of absolute cardiac dulness.

FIG. 23.

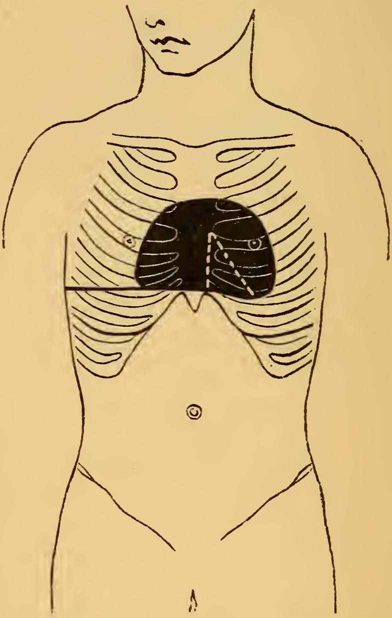


Diagram showing the shape of the absolute cardiac dulness in a case of large pericardial effusion.

The white dotted line indicates the normal area of absolute cardiac dulness.

size, and therefore by increase in the size of the cardiac dulness. This is easily determined unless the lungs and pleura be also affected.

When the cardiac dulness is increased, its shape varies much, according to the kind of disease with which the heart is affected.

The shape may remain triangular and be simply enlarged. This is the rule in all cases of hypertrophy of the left ventricle, of which aortic disease may be taken as the type (*fig.* 21).

Or, it may cease to be triangular, and become either irregularly quadrilateral, as in mitral disease (*fig.* 22), or roughly globular, as in cases of great general enlargement or of pericarditis (*fig.* 23).

Lastly, the cardiac dulness will be displaced when the heart is displaced, or be altered in size and shape in consequence of deformities in the thorax.

SYNOPSIS.

By percussion, then,

1. We determine the size of the **cardiac dulness**,

And 2. Ascertain any alterations in its **size, shape,** or **position.**

AUSCULTATION.

When the ear is placed upon the cardiac region of a healthy man, the two sounds of the heart become audible. They differ somewhat in character, and have been compared to the two syllables "lab" and "dup," the first being longer and heavier (lab), the second shorter and sharper (dup).

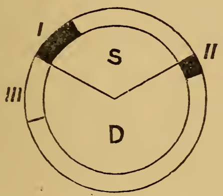
The heart, we know, is in constant movement, either contracting or dilating, and this is true of the auricles as well as the ventricles, but, inasmuch as it is the contraction of the ventricles which is the most important, we agree, when the terms contraction and dilatation are used, to refer to what the ventricles are doing, unless we distinctly specify some other part.

The ventricle then is continually moving, never absolutely at rest, but always either contracting or dilating. Directly contraction ends, dilatation begins, and *vice versâ*.

We may represent the heart's action diagrammatically in the form of a circle (*fig.* 24), once round the circle representing one complete cycle of the heart's action.

The movements of the heart are associated with the two sounds already referred to. These may be represented upon the diagram by shaded spaces cutting the circle, the first much thicker than the second, to indicate its greater length.

FIG. 24.



Diagrammatic representation of the heart's action.
S = the systolic period.
D = the diastolic period.
I = the first sound of the heart.
II = the second sound of the heart.
III = the præsystolic, or auricular systolic, period.

We have, then, in investigating the heart's action to consider, first the two sounds of the heart, and secondly the two intervals by which these sounds are separated. These intervals in health are periods of silence.

It will be observed in the diagram, that the shaded spaces divide the circle into unequal parts, the shorter bearing to the longer roughly the relation of two to three, that is to say, the shorter is two-fifths of the whole circle, and the

longer three-fifths. This is approximately the relation, which has been found by measurement to exist, between the length of the period of contraction and of the period of dilatation.

To the shorter of these periods, the period of *contraction*, the name **Systole** is given, and to the longer, the period of *dilatation*, the name **Diastole.** Systole and diastole are therefore periods of time, and, though they stand in a certain relation to the sounds of the heart, are to be carefully distinquished from them. We have therefore, when listening to the heart, to observe, first the two heart sounds, and secondly the two periods of silence.

The Sounds of the Heart.

The chief cause of the second sound of the heart is the closure of the semilunar valves in the aorta and in the pulmonary artery.

The first sound is more complex, and although it is due in part to the closure of the auriculoventricular valves, other factors appear to be necessary for its normal production, such as a healthy condition of the muscular tissue of the heart and of the blood.

As the result of observation of the heart sounds in disease, it is probable that, even for the second

sound, the simple theory of its production by the closing of valves does not by itself afford a sufficient explanation in all cases.

The valves, however, play so much the most important part in the production of the sounds of the heart, that it will not be necessary in this place, to consider the other possible causes, but we may assume for our present purpose, that the heart sounds are due in all cases alike to the closure of valves.

The first sound is long, rather dragging, and well represented by the syllable "lab." This is indicated upon the diagram by a broad shaded space. The second sound is flapping in character, shorter, and sharper, and is well represented by the syllable "dup." It is indicated upon the diagram by a narrow shaded space.

We have no means at present of measuring the length of the heart sounds. The figure given is diagrammatic, and indicates their duration only approximately.

The first sound of the heart is produced, when the ventricle begins to contract, and marks therefore the commencement of the period of systole. The second sound is produced, when the ventricle begins to dilate, and marks therefore the commencement of the period of diastole. Systole therefore extends from the first sound up to the second; diastole from the second up to the first.

The first sound is sometimes spoken of as the systolic sound, and the second as the diastolic sound. These terms are confusing and should not be used.

The characters of the sounds in health are sufficiently distinct, so that there is little risk of mistaking them, but this is not so in disease, and it becomes necessary to have some means of determining, which sound it is that we hear, or if, as occurs in many cases, the sounds be absent, to determine when the heart is contracting, and when it is dilating, *i.e.*, "**To time the Heart.**"

This is easily done by means of the pulse. The pulse beat is due to the sudden driving of blood into the vessels by the contraction of the left ventricle. Near the heart the pulse beat and the systole of the ventricle are practically synchronous, but at a distance from the heart this is not so, for the wave is delayed in reaching a distant vessel, as for instance the radial at the wrist, and in disease this retardation is often considerable. Some vessel must therefore be selected as near as possible to the heart. The most suitable for the purpose is the carotid.

This will be conveniently reached by grasping the side of the neck with one hand, the fingers being behind, and by pressing the thumb down in front between the sterno-mastoid muscle and the

larynx or trachea. The carotid will then be felt pulsating beneath the thumb.

The pulse wave in the carotid is a long one, and lasts as long as the period of contraction.

Asystolism.

The heart is a complex organ formed of many parts. It might be supposed, then, that we should get many sounds instead of only two, and yet in health the two sides of the heart act in such perfect harmony together, that they produce only one first sound and only one second sound. This is by no means so in disease, for, when this accurate adjustment is disturbed, the two sides cease to act synchronously together, and the sounds become double, or as they are called **Reduplicated.** Instead of a clear "lab-dup, lab-dup," we hear as it were "lar-rab-dur-rup, lar-rab-dur-rup." This has also been called **Cantering** (*Bruit de Galop*).

Either sound may be reduplicated, though it is more commonly the second.

The condition of the heart, under which this reduplication is observed, has received the name of **Asystolism.** This term means merely, that the two sides do not act together at exactly the same time (= *asynchronism*). Sometimes, where the want of harmony is not so marked as this, the

relative loudness of the sounds on the two sides of the heart may be altered. These louder sounds are called **Accentuated.**

Murmurs.

We have stated, that in a healthy heart we hear two sounds only, and that they are separated by two periods of silence. In disease we often hear during these periods of silence a fresh sound, and this we agree to call a murmur.

A Murmur may be defined to be a sound, produced by the movements of the heart, occurring in those intervals, during which in health no sound is audible.

Murmurs must not be confounded with heart sounds, nor must they be spoken of as simply replacing the heart sounds. They may, it is true replace the heart sounds, but then they always do something more, and the two things are essentially distinct.

Murmurs may be heard, when both the sounds are present, or when one of the sounds is absent, or even both of them, and lastly, the heart sounds may be modified, or even absent, without any murmur at all.

The terms, employed to describe the characters of murmurs, are those in ordinary use, such

as *soft, blowing, loud, faint, harsh, grating, rasping,* &c.

Some are musical in character, and are then spoken of as **musical murmurs.** Commonly deep in tone, but occasionally high pitched, such murmurs will be described as *cooing, piping, whistling,* &c., according to the kind of musical sound produced. They frequently change their tone and character, and occasionally the musical part may even for a time disappear. These variations depend upon varying conditions of the circulation.

The vibrations, which produce these musical murmurs, are often also easily felt, and give rise to some of the more striking forms of thrills. Heart murmurs, even when distinctly musical, are not often heard by the patient, however loud they may appear to the person auscultating.

Classification of Murmurs.

Cardiac murmurs are divided into two groups, according as they are produced inside, or outside the heart, and they are named accordingly **Endo-cardial** and **Exo-cardial.**

The exocardial murmurs will be discussed later. Of the **endocardial murmurs** there are two classes,

I. Those which depend upon some pathological

change in the heart, and which are therefore called **Organic**;

II. Those, in which no such change exists, and which are therefore called **Inorganic.**

Murmurs may also be classified according to the movements of the heart.

The heart is always either contracting or dilating, and murmurs, therefore, fall naturally into two groups,

I. Those which occur during the period of contraction (*systole*); these are called **Systolic** murmurs;

II. Those which occur during the period of dilatation (*diastole*); these are called **Diastolic** murmurs.

How to Time Murmurs.

We are able, as we have seen, to determine, by feeling the pulse, the time at which the left ventricle contracts.

If, then, we place our ear upon the chest and our finger upon the carotid, and hear a murmur, we know, should the murmnr come at the same time as the pulse beat, that it occurs when the ventricle is contracting, and that it, therefore, is a systolic murmur. On the other hand, should the murmur not come at the same time as the pulse beat, we know that it is produced when the

ventricle is not contracting, but dilating, *i.e.* during diastole, and that the murmur is therefore diastolic.

We may indicate the murmurs which we hear upon the diagrams, by shading lightly (or in a different colour) the spaces left between the darker shadings, which represent the heart sounds, varying the depth of shading with the intensity of the murmur. Thus *fig.* 25, repre-

FIG. 25.

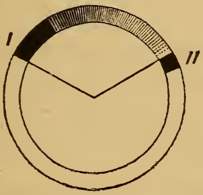


Diagram of a systolic murmur with both heart sounds audible.

The gradually decreasing intensity of the murmur is indicated by lighter shading.

sents a systolic murmur. The shading runs directly into that corresponding with the first sound. This indicates, that the murmur in this case was continuous with the first sound, and could not be separated from it. The shading is darkest towards the first sound, and becomes lighter towards the end of systole. This indicates, that the murmur was loudest at the commencement,

and that it gradually became fainter towards the end, of systole.

In a similar way most varieties of murmurs may be diagrammatically represented.

Subdivision of Endocardial Murmurs.

Systole is a much shorter period of time than diastole, and we do not find it possible to subdivide the class of **Systolic Murmurs.** We content ourselves with speaking of them as and *Long Short.*

Diastole is a longer period and, moreover, when change occurs in the rate of beating of the heart, it is at the expense of the diastole that this chiefly takes place.

Diastolic Murmurs are easily subdivided into two groups, according as they occur at the commencement, or at the end, of the diastolic period.

The murmur at the end of Diastole gradually increases in intensity up to the first sound, and is terminated abruptly by it ; it comes immediately before the systole, or, if we have one finger upon the carotid, immediately before the pulse beat there. It is called, therefore, a **Præsystolic** murmur (*before the systole*) (*fig.* 26). It is usually associated with the peculiar purring thrill previously described.

Now, what is happening in the heart at the time at which this murmur is produced?

We know that immediately before the ventricle contracts, the auricle contracts, so as to ensure the complete filling of the ventricle with blood. But this is just the time at which the murmur is heard. It has for this reason received

FIG. 26.

Diagram of a præsystolic murmur (auricular systolic). The first sound is longer than normal, and the second sound is absent.

The murmur increases in intensity up to the first sound, and is abruptly terminated by it.

the name of **Auricular Systolic**, by which is meant, that it is due to the contraction of the auricle. It is better, however, to use the more common term, and call it **Præsystolic.**

The other kinds of diastolic murmur are heard **at the commencement of Diastole.** They are spoken of as **Long** or **Short.**

The very short murmur of this kind, which occurs immediately after the pulse beat, or if the second sound be present, immediately after the

second sound, has received the name of **Postsystolic** (*after the systole*). It is, however, of but little importance (*fig*. 27).

FIG. 27.

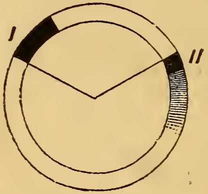


Diagram of a short postsystolic murmur, immediately following and continuous with the second sound, which is still audible.

FIG. 28.

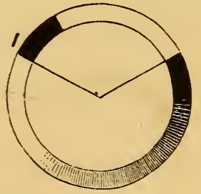


Diagram of an ordinary diastolic murmur (long postsystolic).

The second sound is lost in the murmur.

The most common kind is usually described as **Diastolic**, or, in order to distinguish it from the præsystolic murmur, **Ordinary Diastolic.** This, however, often leads to confusion and seems to imply, that a præsystolic murmur is not diastolic, as it clearly is.

It would be better, I think, to speak of all those murmurs, which occur at the commencement of diastole as **Postsystolic**, and subdivide them into

FIG. 29.

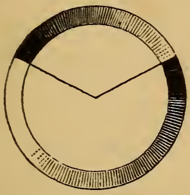


Diagram of a double murmur, systolic and long post-systolic.

Both sounds are lost in the murmurs.

FIG. 30.

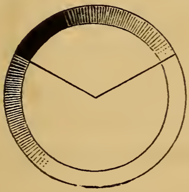


Diagram of a double murmur, præsystolic and systolic.

The first sound is audible and the second absent.

Long and **Short**, the long answering to what is usually called the ordinary diastolic, the short to what is more commonly called the postsystolic.

The murmurs might then be tabulated thus :

- Murmurs
  - Systolic
    - Long.
    - Short.
  - Diastolic
    - Præsystolic = Auricular systolic.
    - Postsystolic, long = ordinary Diastolic.
      short = ordinary Postsystolic.

The Cause of Endocardial Murmurs.

Murmurs in the heart (or vessels) are due to eddies set up in the blood. These will be produced, whenever a current of fluid has to pass through a narrow aperture into a larger space, the eddies thus set up generating a sound.

It might be supposed, with such an explanation, that murmurs would be constantly produced, even in a healthy heart, inasmuch as the blood has to pass through the narrow valvular orifices into the larger cavities of the ventricles or vessels, but, as long as the normal relation exists between the size of the orifices and that of the cavities or vessels, we know that murmurs are not heard ; so soon, however, as this normal relation is disturbed, murmurs are likely to arise.

Theoretically they may depend npon changes of two kinds : first, dilatation of the cavities into which the blood is passing, the orifices being unaltered ; or, secondly, alteration in the condition of these orifices, the cavities remaining normal. These conditions are usually associated. We meet

with both kinds of murmurs clinically, but inasmuch as it is most common to find, when endocardial murmurs have been heard, that the orifices are altered, we will for the present confine our attention to those murmurs which are due to valvular lesions, and consider the means we have of determining at which orifice of the heart the disease exists.

ENDOCARDIAL MURMURS DUE TO VALVULAR DISEASE.

The Place of Murmurs.

Murmurs are transmitted in the direction in which the blood is passing at the time of their production. Let us take an instance. If a murmur is produced at the aortic orifice at the time when the blood is being driven through it by the contraction of the ventricle, the murmur will be carried along the aorta upwards, and will be heard some distance above the valves. In the same way, if the murmur is produced when the heart is dilating, the valves being incompetent, and allowing a stream of blood to pass back through them into the ventricle, the murmurs will be heard below the valves, that is to say, on the ventricular side of them. Murmurs have,

Fig. 31.

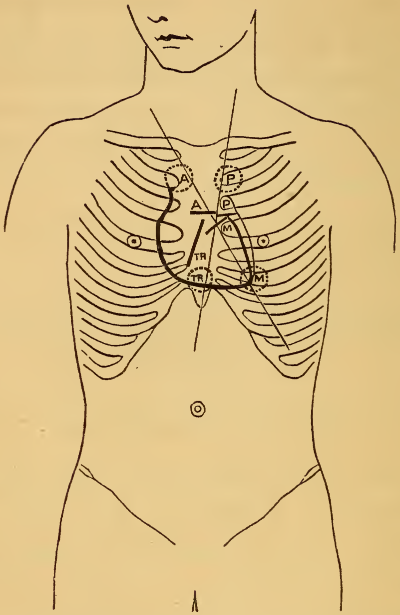


Diagram of the heart, showing the anatomical position of the valves, the axes of the aorta and pulmonary artery, and the places where to put the stethoscope, when examining the different orifices of the heart.

The dark lines A, P, M, TR indicate the actual position of the aortic, pulmonary, mitral, and tricuspid valves respectively.

The thin lines the axes of the aortic and pulmonary orifices.

The circles A, P, M, TR the places upon which to put the stethoscope, when examining the corresponding orifices.

therefore, been spoken of as **Onward** and **Backward** murmurs, that is, murmurs which are propagated onwards, in the direction of the normal current, or backwards, contrary to the normal current. This fact is of the greatest importance, because it gives us the means of fixing with certainty the place at which a given murmur is produced.

We require to know first the normal position of the valves of the heart.

The Position of the Valves.

Anatomically they lie very close together, as is shown in the diagram (*fig.* 31), so that if the mouth of a stethoscope were placed at the junction of the third left costal cartilage with the sternum at its upper border, it would cover the middle points of three out of the four valves, the one not covered being the tricuspid.

At this point, then, it would be impossible to separate the murmurs with certainty, for the pulmonary valve lies immediately above the aortic, and the mitral behind and a little to the left of them both.

If the left hand be loosely clenched, and placed upon the chest, so that the knuckles of the middle phalanges of the fingers rest upon the sternum,

FIG. 32.

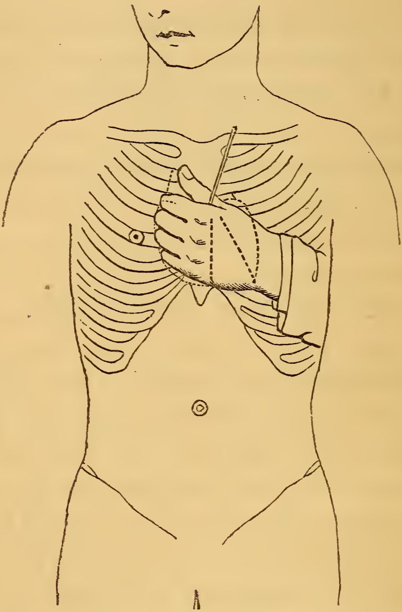


Diagram of the left hand placed upon the chest to represent the size of the heart and the position of its various parts.

Dotted lines indicate the size of the heart (*fig.* 20) and of the absolute cardiac dulness.

For description see text.

we shall obtain a rough estimate of the size of the heart aud of the relative position of its different parts in that individual, as the diagram shows (*fig.* 32).

The row of knuckles represents the line of the tricuspid valve, and what is seen of the fingers towards the right the right auricle. A line, drawn from the knuckle of the first finger to the carpal end of the ulnar, divides the back of the hand into two unequal parts; the larger and lower represents the anterior surface of the right ventricle, the upper and smaller that of the left ventricle, while the line itself corresponds with the septum. The knuckle of the thumb marks the position of the left auricle. If the thumb be now straightened, it will indicate the direction which the aorta takes in the first part of its course; and if a pencil be grasped by the hand, as in the diagram, it will cross the thumb, and lie in a similar position, directed towards the opposite side, and will represent the direction which the pulmonary artery takes in the first part of its course.

The Axes of the Heart.

We may draw a line in the direction of the thumb and of the pencil, and these we may

speak of as the **Axes** or lines of direction of the aorta and of the pulmonary artery respectively.

Now, it is along these axes, onwards or backwards, as the case may be, that murmurs produced at these orifices will be propagated.

By observing, then, in which direction a murmur travels, we are enabled to say with accuracy at which orifice the murmur is produced.

We may define the **Axis of the Aorta** to be a line drawn from the apex of the heart to the right sterno-clavicular articulation, and the **Axis of the Pulmonary Artery** to be a line drawn from the middle of the xiphoid cartilage to the left sterno-clavicular articulation (*fig.* 31).

These lines, it will be observed, cross the end of the second costal cartilage close to the sternum, and if we place the stethoscope upon them in the second intercostal space, right or left of the sternum, we have placed it upon points respectively nearest to one of the valves, and at the same time farthest from the other. We say, therefore, that in order to examine the condition of the aortic valves, we place the stethoscope, in the position indicated (A) in the diagram, in the second right intercostal space, and of the pulmonary valves (P) in the second left intercostal space.

We will now consider more particularly the aortic murmurs.

Systolic aortic murmurs, that is to say, murmurs which are produced at the aortic orifice, when the blood is being driven out of the left ventricle, will travel in the axis of the aorta upwards towards the right sterno-clavicular joint, and will be heard above the valves here or even further in the course of the large arteries. **Diastolic aortic murmurs**, on the other hand, which are produced by the blood passing back again into the ventricle, will be propagated in exactly the opposite direction, that is to say, towards the apex of the heart. They are often transmitted with great intensity along the whole length of the sternum, even as far as the xiphoid cartilage.

Where these murmurs are very faint, they are often not intense enough to reach the apex, and may then be heard at a point in the axis of the aorta short of the apex, the commonest place being on the level of the fourth left costal cartilage. Sometimes it is only in this place that these murmurs are audible.

What has been said of the aorta is true, *mutatis mutandis*, also of the pulmonary artery.

In the case of the mitral valve the difficulties are greater. The line of direction or **Axis of the Mitral** orifice may be roughly taken to be a line drawn from the apex of the heart to the left interscapular space posteriorly, on a level with

the sixth dorsal vertebra. If a long skewer were taken, and thrust into the chest at the apex of the heart, and brought out at the point mentioned behind, it would represent the axis of the mitral orifice, and give therefore the line of direction, which the blood follows in passing from the left auricle into the left ventricle.

If, then, a murmur is produced at the orifice when the ventricle is contracting, it would be caused by a stream of blood passing backwards from the left ventricle into the left auricle in a direction contrary to the normal current of blood. We should expect, therefore, to hear such murmurs posteriorly in the left interscapular space.

If, however, the murmur is produced when the ventricle is dilating, it would be caused by a stream of blood passing in the opposite direction, that is, in the same direction as the normal blood current, and we should expect not to hear it behind.

Now this is just what occurs. Both kinds of murmurs, then, are audible at the apex, but the systolic only behind.

The mitral valve, however, lies so deep down, that the nearest points along the axis, which we can reach, to the valve itself are the apex of the heart in front, where the left ventricle becomes superficial, and the left interscapular space

behind; and these are the spots we choose to listen at, when we wish to examine the condition of the mitral valve. The fourth valve, **the Tricuspid**, lies superficial. Murmurs produced at this orifice we hear best immediately over the valve, that is, along the lower part of the sternum.

The places, then, at which we listen for murmurs at the different orifices are

1. At the aortic, in the second right intercostal space close to the sternum;
2. At the pulmonary, in the second left intercostal space close to the sternum;
3. At the mitral, at the apex of the heart;
4. At the tricuspid, at the bottom of the sternum.

But it is not sufficient to note the presence only of a murmur at these places. We must also carefully trace the direction in which it is propagated, and determine especially the spot at which it is heard loudest, *i.e.* its place of maximum intensity.

The Diagnosis of Valvular Diseases.

Now, at each of these places we have to consider, as has already been stated, first, the two sounds of the heart, and, secondly, any

murmurs which are heard between them, and we may therefore construct for each of these spaces a diagram similar to that already described.

The heart being thus a complex organ, all the various parts of which stand in such close relation in action to each other, we should expect to find, that it would be almost impossible to meet with any change in one part, which was not associated with correlative changes in other parts. Hence the rule to examine each and every part of the heart, and to note carefully every one of the changes there detected, before venturing to make a diagnosis of any disease.

We have therefore four places to listen at, and at each of these places we have two sounds and two intervals to consider.

The sounds may be both present, or one or both absent. They may be accentuated or reduplicated.

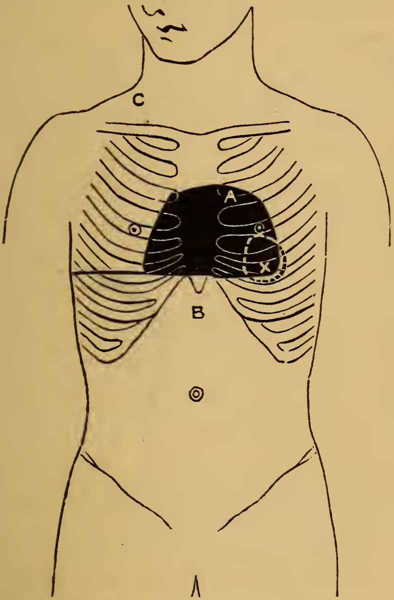
If murmurs be present, we have then to determine to which of the intervals they belong, *i.e.* whether they be systolic or diastolic; and if diastolic in which part of the diastole they occur.

Examination of the heart, then, is a complicated undertaking, and must be conducted systematically, if a correct diagnosis is to be made.

It is well to represent, so far as possible, all

the information we can obtain in a diagrammatic form.

FIG. 33.



Complete diagram of a case of mitral stenosis. The black area shows the size and shape of the absolute cardiac dulness.

A. Valve shock.

B. Epigastric pulsation.

C. Venous pulsation. Veins dilated.

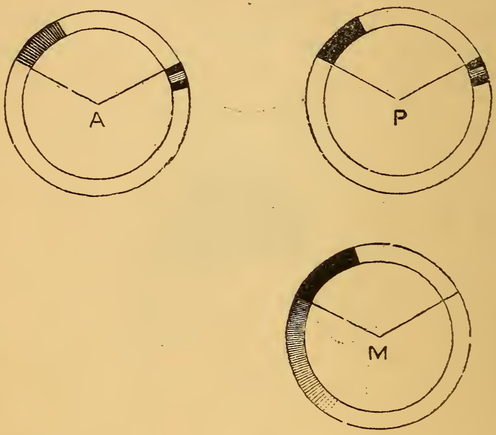
Dotted circle indicates the area within which the murmur is heard and a præsystolic thrill felt.

X. Shows the point of maximum intensity.

For the purpose of illustration a simple and well-marked case of mitral stenosis has been

selected, that disease which gives rise to the præsystolic murmur already frequently referred to.

FIG. 34.



A is the representation of what is heard in the second right, P in the second left intercostal space, and M at the apex.

The pulmonary sounds are louder than the aortic. This is indicated by darker shading, and the second sound is reduplicated.

At the apex the first sound is prolonged and loud, the second sound is absent, and there is a long præsystolic murmur.

Such diagrams are much easier to read than long verbal descriptions, and the construction of them tends to clearness of conception.

ENDOCARDIAL MURMURS NOT DUE TO VALVULAR DISEASE.

We are now in a position to consider some of the other kinds of murmurs audible in the cardiac region.

The remaining organic endocardial murmurs are due for the most part to roughenings or little outgrowths (*vegetations*) from some part of the inner walls of the heart, and occasionally to local pouchings (*aneurysms*) of the heart walls.

These conditions are all of them rare, and are sometimes impossible to diagnose. The points upon which chief stress would be laid, are the evidences of some organic heart disease, but without the physical signs which indicate any of the ordinary forms of valvular lesion.

INORGANIC MURMURS.

The **Inorganic Murmurs**, *i.e.* those not associated with gross pathological change in the heart, form a large and important class.

They are rarely loud, harsh, murmurs, but for the most part soft and blowing, and are nearly always systolic.

They may be heard in almost any part of the cardiac area, but they are not propagated, as a rule, along the various axes, as organic murmurs are, and they vary much in different individuals, and even in the same individual at different times.

Their varying character, and their usual disappearance in the course of time, are points of diagnostic importance, but they are frequently very difficult to distinguish from some of the murmurs due to organic lesions.

The commonest form of inorganic murmur is heard in the second left intercostal space near the sternum and a little below this place. It is called a **Pulmonary Systolic** murmur, and is referred usually to the eddying of the blood, as it passes the pulmonary orifice.

A similar systolic murmur is often heard lower down in the third space just within the left

nipple line. This is possibly produced in the left auricle.

Or again, between the left nipple and the apex of the heart, and this is probably produced in the left ventricle.

The loudest and also the rarest inorganic murmur is heard over the right ventricle in the region of the **Tricuspid** valve.

All these murmurs, as has been already stated, are systolic. So far as we know at present, diastolic inorganic murmurs do not occur in the cardiac region.

The causes of these murmurs are not yet quite established.

From the fact that they are very commonly found in conditions of great anæmia, they have been attributed to an altered condition of the blood, and have been called **Anæmic, Hæmic,** or **Blood Murmurs.** As the condition of the blood is only one of the factors in their causation, and inasmuch as there is also in most of these cases dilatation of the heart, it seems probable, that many of these murmurs are due to this cause, and they are now often called **Dilatation Murmurs.**

Such murmurs have for a long time been referred by many writers to regurgitation through the auriculo-ventricular orifices. Although it is difficult to understand, if this be the true explanation, why anæmic murmurs on the left side of the

heart are not, like the ordinary regurgitant mitral murmurs, audible behind.

When dilatation is extreme, the auriculo-ventricular orifices certainly become permanently stretched, and too wide for the valves to close them completely. In this way regurgitation of the blood will occur, and a loud murmur be produced, which may be extremely difficult to diagnose from the murmur due to regurgitation from organic disease of the valves. Such regurgitation from stretching may occur on both sides of the heart, but it is commoner on the right side, and is the ordinary cause of systolic tricuspid murmurs.

EXOCARDIAL MURMURS.

Of the exocardial murmurs the most important is that, which is due to the rubbing together of the two layers of an inflamed pericardium.

The healthy pericardium is smooth, and the movements of the heart within produce no sound. So soon, however, as the pericardium becomes roughened, as it does in pericarditis, a sound is produced.

This has received the name of **Pericardial Friction.**

It is *rough, rubbing, grating* in character, nearly always double (*to and fro*). It appears *superficial, i.e.* close beneath the ear. It is usually not audible over a wide area, *i.e.* it is *localised* or limited in extent. It does not bear the same strict *relation to the heart sounds*, and is *not propagated* in the way that endocardial murmurs are. It frequently *alters with the position* of the patient, a phenomenon so unusual with other murmurs that it has been spoken of as pathognomonic of pericarditis.

In most cases pericardial friction is easy to diagnose from the character of the sound alone, but in doubtful cases the correct diagnosis will be made by observing the relation of the mur-

mur to the intervals of the heart, the effects of position, and the direction of propagation.

The chief difficulty will arise, when the pleura is inflamed over the pericardium, from the fact that the movements of the heart may then cause a friction sound by rubbing the two layers of the roughened pleura together. Such friction is called **Pleuropericardial**, its seat being not in the pericardium, but in the pleura over the pericardium.

Pleuropericardial friction is often altered by respiration, for a deep inspiration forces the lung between the two layers of roughened pleura and separates them, so that the friction will disappear for the time, to return again on expiration. This does not always happen, and in some cases respiration has no effect upon the sound. The difficulties of diagnosis will then be very great.

Murmurs are occasionally heard over the præcordium, which have their seat not in the heart, but in the lung. They are produced probably by air being suddenly forced out by the movements of the heart from a portion of the lung in immediate relation with it, with force sufficient to produce a distinct blowing sound.

Such murmurs are extremely rare.

MURMURS AUDIBLE IN OTHER PARTS OF THE THORAX.

Aneurysms or dilatations of the aorta, or occasionally the pressure of a mediastinal tumour upon the large vessels, may give rise to murmurs, audible under the first piece of the sternum, or to one side of it.

They are generally systolic, though sometimes double, and are not easy to diagnose from murmurs due to disease of the aortic valves.

In children a continuous murmur is sometimes heard in this place, when the head is thrown back, produced, it is stated, in the veins, by the pressure of large lymphatic glands in the mediastinum. This explanation is, however, doubtful.

Beneath the clavicle, a systolic murmur is frequently heard, the **Subclavian Murmur.**

Its seat is in the subclavian artery, though its causes vary in different cases.

It is sometimes due to compression of the artery by the muscles or by the stethoscope, and is then altered, or made to disappear, by changing the position of the arms or the pressure of the stethoscope. In other cases it occurs in connection with phthisis, and has been then referred to pinching of the arteries by

adhesions at the apex of the lung, and, lastly, it may be due to aneurismal dilatation of the artery.

A similar murmur, associated with vascular dilatation, is common in cases of exophthalmic goitre over the thyroid gland.

Murmurs are frequently heard, also, in the **Vessels of the Neck**, both arteries and veins. Their commonest seat is in the root of the neck, just above the clavicles.

In the Arteries, the murmur is systolic, and occurs in cases of anæmia. Such anæmic arterial murmurs are often difficult to diagnose from the murmurs propagated upwards along the vessels in cases of disease of the aortic valves.

Venous Murmurs are sometimes heard in healthy people but are commonest in that form of extreme anæmia, which is called chlorosis.

When in such a patient the stethoscope is placed above the clavicle over the origin of the sterno-mastoid muscle, a continuous blowing or rushing sound is heard, often mingled with humming, or buzzing, semi-musical sounds, which have been compared with the buzzing of a fly.

This is the **Bruit du Diable** or Nonnen-Geräusch. It is loudest usually on the right side. It is increased by pressure, although pressure alone is not sufficient to produce it, and may destroy it. It

increases in intensity with whatever increases the rapidity of circulation through the veins. Hence it is loudest in the erect position, during the diastole of the heart, and during inspiration.

The seat of the murmur is in the veins, for compression of the vessel with the finger above stops the murmur, with a pressure too small to have any effect upon the artery.

Various explanations have been given of the murmur. It has been attributed to the peculiar condition of the blood (spanæmia), but as it is not heard in all cases of anæmia, it is more satisfactory to refer it, as also those similar murmurs in the heart, to a condition of dilatation.

The anæmia produces from malnutrition a relaxed condition of the muscular tissue, the relaxed vessel dilates, wherever it can. Where, however, it passes through dense fascia, as at the root of the neck, this dilatation is prevented, and we have in this way produced a dilatation above and below, with an apparent constriction in the middle, the exact physical conditions for a murmur.

SYNOPSIS.

On Auscultation then we have to investigate,

1. The **Sounds** of the heart :
2. The **Intervals** between them :
3. If **Murmurs** be present **in the Cardiac Region** ;
    1. Whether they are systolic, or diastolic, and if diastolic, to which part of the diastole they belong ;
    2. Their place of maximum intensity ;
    3. The direction in which they are propagated ;
    4. Any special peculiarities they may present :
4. **Murmurs elsewhere** ;
    1. Under the Manubrium Sterni ;
    2. In the vessels of the neck,
        1. Arteries ;
        2. Veins ;
    3. Beneath the clavicle.

SYNOPSIS OF THE EXAMINATION OF THE HEART.

Inspection.

1. **The Shape** of the præcordial region.
2. **The Movements**, the apex beat.
   impulse elsewhere.

Palpation.

1. The position of **The Apex**.
2. **Impulse elsewhere.**
3. **Thrills, Valve-shock, Friction.**

Percussion.

The Cardiac Dulness, its size, shape, and position.

Auscultation.

1. **The Sounds** of the heart.
2. **Murmurs.**
3. **Friction.**
4. **Murmurs elsewhere** in thorax or neck.

SECTION III.

THE PULSE.

THE EXAMINATION OF THE PULSE.

WHEN the left ventricle contracts, the blood, which is driven into the aorta, travels through the arteries in the form of a wave, and distends them, as it passes along.

It is this wave of distension, which is felt, when the finger is placed upon the artery, and which is spoken of as the pulse.

The Pulse might be examined in any superficial artery, but the **Radial** at the wrist is usually selected, because it is easily accessible, lying, as it does, close under the skin, and upon a solid backing of bone.

In health, every contraction of the heart produces a beat at the wrist, and we therefore commence the examination of the pulse by counting the **Number of Beats** in the minute. This is called the **Pulse Rate.**

The Pulse Rate varies much in different individuals according to age, sex, temperament, &c., and also in the same individual under different

conditions, *e.g.* rest, exercise, emotion, &c., but the average in a healthy young man at rest is about 70, and in a woman about 80. In young children it is more rapid, and reaches 90 or 100, while in infants it is about 120 (*cf. Table*).

PULSE RATE AT DIFFERENT AGES.

(From Carpenter's 'Physiology.')

	Beats per minute.
In the fœtus in utero . . .	140—150
Newly-born infant . . .	130—140
During 1st year . . .	115—130
„ 2nd year . . .	100—115
„ 3rd year . . .	90—100
From 7th to 14th year . .	80—90
„ 14th to 21st year . .	75—80
„ 21st to 60th year . .	70—75
Old age	75—80

In disease the number may rise to 140 or 150, and in children even up to 200.

The beats then become often so rapid, that they appear to run into one another, and cannot be counted. The pulse is then called **Running.** The number rarely falls below 50, although cases are recorded, in which it did not exceed 40 or occasionally 30, or even less.

The character of the wave will of course be much affected, not only by the force with which the heart contracts, and the amount of blood driven into the vessels, but also by the condition of the vessels themselves.

These different conditions must be clearly distinguished in making an examination of the pulse, and, before considering the characters of the pulse wave, we require to know all that we can ascertain about the condition of the artery itself, and the amount of blood which it contains.

The Course of the Artery.

A healthy radial artery runs a straight course down the forearm, but in disease and old age it is often much twisted, or, as it is called, **Tortuous.**

The only superficial artery which is normally tortuous is the temporal.

The Coats of the Artery.

To estimate the thickness of the walls of an artery the tip of one finger, usually the index, is placed upon it, and pressed down so as to flatten it against the bone, and then moved slowly over it from side to side.

In a healthy young person, the coats are thin and smooth, and flatten out under pressure, so as to lie like a piece of folded tape, and to be hardly detected under the finger.

With increasing age, they normally become somewhat thicker, and are, therefore, more easily felt in the middle aged than in young persons.

In disease and old age, the **Thickening** is often

so considerable, that the artery seems like a piece of thick straw, or even in extreme cases like a small pipe stem, and may be made to roll from side to side distinctly under the finger.

This thickening is usually due to a disease of the inner coats called atheroma, which sometimes affects the whole vessel **Uniformly**, at other times only parts of it, occurring then in **Patches**, which can often be easily felt.

In other cases, as in granular kidney, the thickening is due to a **Hypertrophy** of the muscular or fibrous part of the artery, and is therefore uniform aud general.

Calibre of the Artery.

But, apart from pathological change, the coats will *appear* to be thicker or thinner, according as the vessel is contracted or dilated. This of course stands in direct relation with what we have to consider next, viz. the **Calibre of the Vessel**, or the size of the column of blood which it contains.

The blood in an artery is under pressure and tends therefore to dilate the vessel. This is resisted by the muscular and elastic tissue in its coats. As long as these opposing forces are normally related to one another, so long the calibre of the vessel will remain normal.

Dilatation may therefore occur in two ways, either in consequence of a deficiency of tone, as in fevers, or in consequence of an increase of internal pressure or tension.

Similarly contraction may occur, either in consequence of an excess of tone, as in granular kidney, or in consequence of a decrease of internal pressure, as in hæmorrhage.

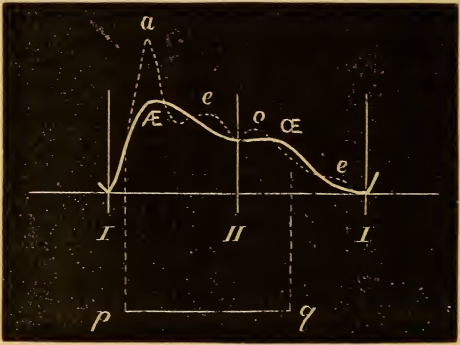
In dilatation, the coats will feel thinner, and the artery softer and more easily compressible.

In contraction, the coats will feel thicker, and the artery harder and less easily compressible.

What the normal relation is between the thickness of the coats of a healthy artery and its calibre, can only be learnt by experience, but in all cases, as long as the vessel can be flattened out by pressure, so as to be not more distinctly felt than a piece of folded tape would be, so long the thickness, whatever this may seem to be, is only apparent and not real.

Hard, soft, easily compressible &c., are terms often used in descriptions of the pulse, but they are confusing, for they may apply to very different conditions. Thus, for instance, a cannon ball and a football are both hard, and not easily compressible, but for different reasons. In the one case the walls are rigid, and in the other the walls are tense. In describing the pulse it is

FIG. 35.



The white line indicates the true curve of the pulse, the dotted line the sphygmographic tracing.

I and II show the times at which the 1st and 2nd sounds of the heart occur. The systole lasts therefore from I to II, and the diastole from II to I.

The wave, which is felt distinctly by the finger, corresponds in length with the line *p*, *q*.

The single wave Æ is split up by the sphygmograph into the two waves *a* and *e*, and the second single wave Œ into the two waves *o* and *e*.

The diagram is taken, with modifications, from Dr. Galabin's Thesis for M.D. Cantab., 1873.

most important to distinguish between these different conditions.

The Pulse Wave.

To examine the pulse wave, one finger say the index, is placed upon the artery with just sufficient pressure to feel the vessel when no wave is passing. When it passes, the finger will be jerked up, kept up for a short time, and then allowed gradually to fall, and we shall be able to form an estimate of the force, size, speed, and form of the wave.

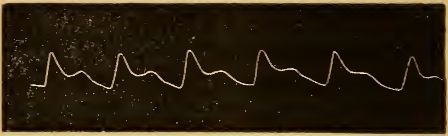
By means of the **Sphygmograph** all these various facts may be recorded in a graphic form, the pulse or sphygmographic tracing (*fig.* 35).

In the diagram a white line indicates what is probably the real curve, aud it differs in many respects from the sphygmographic tracing, which is represented by a dotted line.

These differences are due chiefly to defects in the instrument, the lever being jerked up too high and then falling too low, and in this way giving a double wave where there ought only to be one.

The sensation conveyed to the fingers represents more nearly the real curve. This, we see rises sharply, then subsides slowly for some distance, until it is interrupted by another slight

FIG. 36.

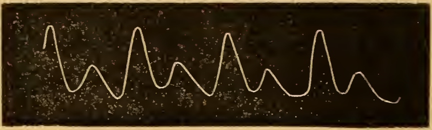


Normal pulse tracing.

FIG. 37.

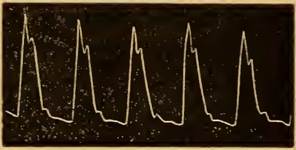
Tracing of a pulse of increased tension from a case of granular kidney (square top).

FIG. 38.



Tracing of a dicrotic pulse.

FIG. 39.



Pulse tracing from a case of Aortic Incompetence. Water-hammer pulse.

(Sudden rise and sudden fall.)

rise, after which it finally falls more rapidly down to the level from which it started.

The only part which we feel distinctly is the top of the wave between Æ and Œ in the diagram, and it is in this part that the most characteristic changes occur.

The whole pulse wave extends of course from I to I, that is, from one beat to the next. A long wave would then be the same thing as a slow pulse.

When we speak of a long wave in this sense, it will be better to call it a rapid or slow pulse, because we really refer to its frequency, and this will be discussed later, and because long and short are more commonly used in reference to the top or head of the wave (corresponding with the line *p q*) than to its total length.

The parts of the wave to examine most attentively are the upstroke or rise, and the top or head.

The Upstroke may be **abrupt** (*fig.* 39) or **gradual** (*fig.* 40), high (*fig.* 39) or low (*fig.* 37).

The **Top of the Wave** (*p* to *q*) represents the maximum tension in the vessel. If it be well sustained (*fig.* 36 and 37), the subsidence will be gradual, if ill sustained, it will be abrupt (*fig.* 39.)

Where it is gradual, the wave will appear long, and seem to pass slowly under the finger, and

where it is abrupt, it will appear short, and seem to pass rapidly under the finger.

This is what is meant generally by a **Long** and **Short Wave.**

When the tension is very low, the second wave (Œ) is often well marked, and is sometimes as large and as distinct as the primary wave. The pulse is then felt as a double beat, and is called **Dicrotic** (*twice beating*) (*fig.* 38).

In some other rarer cases, instead of two distinct waves, several smaller ones are felt, and the pulse is called **Thrilling.**

These thrills may in some conditions of the artery be produced by pressure, and on this account it is important to feel the pulse only with one finger, lest by a little unequal pressure vibrations may be set up, and the pulse made artificially thrilling.

One of the most peculiar forms, and at the same time one of the most important clinically, is known as the **Waterhammer Pulse** (*fig.* 39). This is pathognomonic of incompetence of the aortic valves. It is characterised by a very high upstroke and by very short duration.

It is a short sudden wave, and conveys to the finger the sensation of a sharp forcible jerk, the artery seeming to empty itself and collapse completely, almost immediately after the beat has been felt.

The high upstroke is caused by the great force with which the blood is driven into the arteries, for the left ventricle is hypertrophied.

The short duration or sudden collapse is due to the fact that the aortic valves do not close, so that the blood flows back from the aorta into the ventricles, and the tension in the arteries is not sustained.

The position of the arm makes a great difference in the distinctness with which the characters of this pulse are felt at the wrist. If the arm hang down, the force of gravity tends to keep the artery fairly full, but, if the hand be raised above the head, it helps to empty it, and the peculiarity becomes more marked.

This pulse is also known by other names;

1. **Corrigan's Pulse**, from Dr. Corrigan who described it;

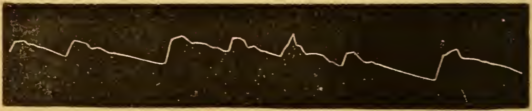
2. **The Locomotor Pulse**, from the peculiar way, in which the impulse seems to travel down the arm, when it is so exposed that the whole length of the artery is visible;

And 3. **The Pulse of Unfilled Arteries**, because they so quickly empty themselves. If the stethoscope be placed over a large artery, like the brachial or femoral, in such a case, a heavy thud is often heard, synchronous with the pulse. Possibly this may have given origin to the name waterhammer.

Rhythm of the Pulse.

In a healthy pulse the waves are equal in size, and follow each other at equal intervals of time. Where this is not so, the pulse is called **Irregular,** and it may be irregular (1) **in Force,** *i.e.* in the size of its waves, (2) **in Frequency,** *i.e.* in time, or (3) as is most common both in force and frequency (*fig.* 40).

FIG. 40.



Pulse tracing from a case of Mitral Incompetence. Pulse irregular in force and frequency.

Irregularity of the pulse is usually due to irregular contraction of the heart, as the result either of muscular weakness or of impaired nerve control.

Any nervous excitement may make both heart and pulse irregular for the time. And in some acute diseases of the brain and upper part of the spinal cord the rhythm of the pulse is often of diagnostic importance. In these cases the beats both of heart and pulse follow one another appar-

ently with regularity, but the frequency varies much from time to time even to the extent of 10 or 15 beats in consecutive minutes.

As a matter of routine then the pulse should be counted two or three times at short intervals.

Muscular weakness of the heart often shows itself in the pulse by irregularity of force, *i.e.* in the size of the waves; but this is usually associated also with irregularity in time.

When this weakness is great, some of the beats may fail to reach the wrist and the pulse is then called "**Intermittent.**" In extreme cases, the pulse may be entirely absent at the wrist, the heart not having power to drive a single wave so far.

In these cases any slight extra work thrown upon the heart, even for example, the effort of standing up, may increase the difference between the number of beats at the heart and at the wrist.

Although in most cases irregularity of the pulse is due to irregularity of heart action, there are cases in which the pulse is markedly irregular, while the heart continues to beat regularly.

This irregularity is generally synchronous with the respiratory movements, and in this way regular oscillations in the pulse tracings are produced.

In health this is not detected except by delicate apparatus in the large vessels near the heart, but, where the circulation is feeble, it may be observed at the wrist in an irregularity, not only of force but also of time, synchronous with the inspiratory movements of the chest.

In the most extreme form, this gives rise to the **Pulsus Paradoxus**, (*fig.* 41), or **Pulsus cum**

Fig. 41.

Pulsus Paradoxus. Pulsus cum Inspiratione intermittens. Taken from a case of Purulent Pericarditis.

The pulse is very dicrotic, the second wave being almost as large as the first. The horizontal line indicates the remissions due to inspiration, and lasting for two or three heart beats.

Inspiratione intermittens. The pulse beat then disappears entirely during inspiration, and often hardly a trace of vibration can be detected even upon an enlarged sphygmographic tracing. In the most typical form the heart remains perfectly regular, both in force, as judged by the loudness of the heart sounds, and in time.

The typical pulsus paradoxus is very rare. Its causes vary. In some few cases, the heart seems to be in such an extreme condition of muscular

feebleness, that it is unable to overcome even the very slight increase of work, which inspiration throws upon it.

In most cases, however, the pulsus paradoxus is found to be caused by adhesions or bands, which surround the large vessels either in the mediastinum or within the pericardium, in such a way that, when the chest expands on inspiration, they are tightened, the vessels compressed or pinched, and the pulse wave stopped.

Want of Symmetry.

The pulses in the two wrists in health are exactly symmetrical, both in time and force, the only allowance, that may have possibly to be made, is for an anatomical difference in the size of the vessel, but this does not often prove to be a practical difficulty.

In disease of various kinds, the artery of one side may be twisted, pressed upon, stretched, or displaced in such a way as to obstruct the circulation through it, and thus a **Want of Symmetry** will be produced.

Usually this shows itself in an alteration in **the Character of the Wave** on the affected side, which may be recognised by the finger and described upon a sphygmographic tracing, but

besides this the wave is often **Retarded**, so that it reaches the wrist on the affected side at a perceptibly later time.

These, like all other defects of symmetry, are of very great practical importance in the diagnosis of disease.

SYNOPSIS OF THE EXAMINATION OF THE PULSE.

I. The Artery.

- **1. Its course, straight, tortuous.**
- **2. Its coats**
  - thinned.
  - thickened
    - *a.* Uniformly.
    - *b.* In patches.

II. The Calibre of the Vessel, *i e.*, the size of the column of blood it contains, and the relation between it and the thickness of its coats.

III. The Pulse wave.

- **1. Its frequency,** *i.e.* the number of beats in the minute.
- **2. Its rhythm**
  - **Irregular**
    - in force,
    - or in frequency.
  - **Intermittent.**
- **3. The wave.**
  - **1. Its rise, high or low.**
  - **2. Its head**
    - long and short.
    - rapid or slow.
  - **3. Its character** (dicrotic, thrilling, waterhammer, &c.).
  - **4. Its symmetry,** in time and force.

SECTION IV.

THE MEDIASTINUM.

THE EXAMINATION OF THE MEDIASTINUM.

The Mediastinum is the irregular space, extending from the first rib to the diaphragm, and lying between the sternum in front, the spine behind, and the lungs on either side.

Part of this space is occupied by the heart, the rest contains the large arteries and veins connected with the heart, the trachea and the roots of the lungs, the œsophagus, and thoracic duct, with numerous nerves, small vessels, and glands.

Dislocation of the Mediastinum.

All these structures are intimately connected together, and form a mass which is firmly fixed below by its attachment to the diaphragm, and posteriorly and above by its attachment to the spinal column, so that vertical displacement is hardly possible. With the sternum, however, the connections are loose, so that **Lateral Displace-**

ment may occur by a kind of rotation, as a door swings upon its hinge, the hinge in this case being the aorta, where it is fixed to the spine.

The mediastinum remains in the middle line in health. Not because it is "fixed" there, but because of the equal balancing of the forces, which tend to displace it on either side. The chief of these is the elasticity of the lungs.

If air be admitted freely into one pleural cavity, the lung on that side collapses, and the elasticity of the other lung, being unopposed, comes also into play. This lung, then, also contracts, and in doing so *pulls* over the mediastinum.

If one pleural cavity be greatly distended by air or fluid, the mediastinum will be *pushed* over by the pressure and will be still further displaced (*figs.* 15 and 16).

On the other hand, if one pleural cavity be contracted, as with the fibroid thickening, which often occurs after chronic pleurisy, the mediastinum will be *pulled* over, just as the ribs on that side are pulled in (*fig.* 14).

The Physical Signs of Displacement of the Mediastinum en masse are

1. Those of displacement of the heart (*q. v.*) ;
2. Those of displacement of the anterior boundaries of the lungs (*q. v.*).

These have been already discussed, and need not be further referred to here.

The parts of the Mediastinum.

The Heart, although strictly included in the mediastinum, has been already described in a separate chapter.

The Rest of the Mediastinum is not so easily accessible.

The places where it is examined are

1. **In front,** beneath the upper part of the sternum;

2. **Behind,** on either side of the dorsal vertebræ in the interscapular spaces.

Diseases of the Mediastinum.

In front, the mediastinal region extends from the episternal notch down the sternum to the level of the fourth costal cartilage.

This part in health is slightly prominent, moves slightly with respiration, and is resonant to percussion. Beneath it, distinct tracheal or bronchial breathing and resonance, are usually audible.

Apart from affections of the lungs and pleura, which may modify the physical signs here (p. 54, &c.) the diseases of this part are chiefly two, each attended by the formation of a **Tumour,** viz. **Aneurysm** or **New Growth.**

In either case the lungs are pushed aside by a

FIG. 42.

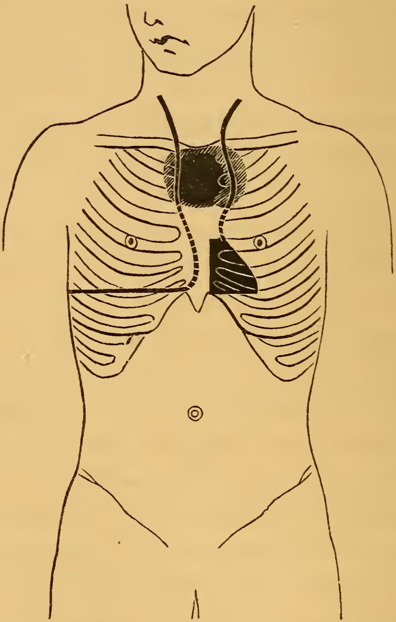


Diagram of a Mediastinal Tumour. The shaded area beneath the manubrium and upper ribs indicates the area of impaired percussion resonance.

The edges of the lungs are retracted, or pushed aside by the mass beneath.

mass, and their place beneath the sternum is taken by the non-resonant tumour (*fig*. 42).

The percussion will be, therefore, impaired or dull, and, as in the lungs, we shall obtain usually the physical signs of consolidation, viz. increased vocal vibration, increased vocal resonance, and increased breathing sounds. In addition there may be present in some cases **Bulging, Pulsation, Thrills,** or **Rubbing,** and occasionally also **Vascular Murmurs.**

Posteriorly, in the interscapular spaces, the same two diseases are met with, and may give rise to the same physical signs.

Impairment of percussion is, however, much more difficult to make out, because of the thick muscular covering to the ribs, the percussion note here being normally deficient in tone, but of course symmetrical. Want of symmetry is what we look for, and this is often very distinct, so far as vocal vibrations, vocal resonance, and breathing sounds are concerned, although the other physical signs which are occasionally present in front, viz. bulging, pulsation, thrills, friction and murmurs, are very rarely obtained behind.

Where the tumour is large, not only the lungs but also the heart and diaphragm may be pushed out of place, and we shall then have, in addition, the ordinary physical signs of displacement of these organs.

The Diagnosis of Diseases of the Mediastinum.

The diagnosis of mediastinal affections, by means of the physical signs alone, is often very difficult, especially when the disease is not extensive, and is deeply seated, and it is then rather upon the secondary symptoms, to which the disease gives rise, than upon the physical signs, that the diagnosis depends.

These **Secondary Symptoms** are for the most part due to mechanical interference, by pressure, with the function of the various organs in the thorax.

What these symptoms may be, depends upon the part pressed upon, and varies according to the seat of the disease, and, to determine this, a very intimate knowledge of the relationship of the different parts in the mediastinum is essential. These are given in detail in any good work on anatomy. It will be sufficient for our present purpose to group the various symptoms together with reference to their cause, and to indicate in this way the use, which may be made of them for diagnosis.

I. **Pressure upon the Vessels** will lead to interference with the circulation through them.

When **the Veins** are compressed, the part of

the vessel on the side away from the heart will be distended, and an attempt will be made to establish the circulation through collateral channels. This will give rise then, first, to *Distension of the Large Veins* above the seat of pressure, as is especially common in the lower part of the neck, or on the shoulders, and, secondly, to abnormal *Dilatation of the Subcutaneous Veins* usually over the front of the chest.*

In both cases the distension is usually unsymmetrical.

It is important to determine in all these cases the direction in which the blood is travelling in the dilated vessels, in the way described at p. 20.

The circulation through **the Arteries** may be interfered with, either as the result of direct pressure upon them, or in consequence of the vessels being so twisted or stretched at their origin, that their mouths are obstructed.

In either case **the Pulse**, cardiac or radial, will become unsymmetrical. There will be a difference either in force or in time, that is to say, one pulse will be either *Smaller* than the other, or will reach the wrist later than the other, *i.e.* be *Retarded.*

* The physiological dilatation of the mammary veins referred to at p. 20 must not be confounded with this pathological dilatation.

Pressure upon either arteries or veins may produce a *Murmur,* audible of course near the seat of pressure. In the arteries it is usually *Systolic,* and in the veins often *Continuous.*

II. **Pressure upon the Respiratory Tract** will lead to interference with respiration, and give rise to *Dyspnœa, Stridor,* or *Cough,* all of which are frequently *Paroxysmal.*

Dyspnœa may be due to pressure upon the trachea or bronchus, or directly upon the lung itself, and similarly cough may be the result of irritation of any of these parts.

Stridor, whether in breathing, speaking, or coughing, on the other hand, is always evidence of pressure upon the trachea or bronchi, if there be not a local affection of the larynx to account for it, as can easily be determined by laryngoscopic examination.

Where the pressure is upon the trachea, the air will have difficulty in entering both lungs equally, but where it is upon the bronchus or lung of one side, the obstruction is unilateral, and, therefore, we shall find a want of symmetry in the physical signs; the vocal vibrations and the vocal resonance may be weaker than on the unaffected side, and the respiratory murmur may be feebler or often altered in character, expiration especially becoming prolonged and occasionally wheezing.

The place to examine for these altered physical

signs is as far away as possible from the root of the lungs, where, as a rule, the obstruction exists; and the most convenient part to select is low down at the base of the lungs posteriorly, *i.e.* in the infra-scapular region.

In such cases as these a slight want of symmetry may be of great importance.

III. The symptoms of **Pressure upon the Nerves** vary with the nerve affected, and with the amount of pressure, slight pressure producing the results of irritation, and considerable pressure those of paralysis.

The nerves are the Pneumogastric, the Phrenic, the Sympathetic, and the Intercostal.

1. Of these, the most important is the **Pneumogastric**, distributed, as it is to the larynx, lungs, and heart.

The *Recurrent Laryngeal Branch* on the left side, where it winds round the arch of the aorta, is especially exposed, and is therefore often affected.

Irritation of this branch, as also of the pulmonary branches of the pneumogastric, commonly produces attacks of *Spasmodic Dyspnœa*, which are sometimes fatal.

Paralysis, on the other hand, expresses itself in loss of voice, *Aphonia*, in consequence of paralysis of the vocal cord upon the side affected.

The effect upon the heart is usually to produce

Irregularity, Palpitation, and *Paroxysmal Pain,* and occasionally sudden death from *Syncope.*

2. *Pressure* upon the **Intercostal Nerves** gives rise to *Pains,* referred usually to their peripheral distribution on the side or front of the thorax, or occasionally following the course of the intercosto-humeral nerve, down the inner side of the arm as far as the elbow.

Paralysis of the intercostal nerves is not common.

3. **The Phrenic Nerves** usually escape or at all events the diaphragm rarely gives evidence of any affection, when only one phrenic is involved.

4. **The Sympathetic Nerves** enter largely with the spinal nerves into the various plexuses in the thorax, and cannot be separated in their action from the spinal nerves already referred to, unless certain alterations in the rate of beating of the heart be attributed to their influence.

IV. **Pressure upon the Thoracic Duct** produces no symptoms, by which it can be diagnosed, although theoretically it might be the cause of anæmia and malnutrition.

V. Lastly, **Pressure upon the Œsophagus** causes *Dysphagia, i.e.* difficulty in swallowing either solids or liquids, and occasionally, where the obstruction is considerable, it may lead to *Regurgitant Vomiting.*

It is the combination and association of these various symptoms, which make it possible to determine in a given case the locality of a tumour in the thorax.

All that the physical signs enable us to establish in many cases is the presence of a tumour in some part of the mediastinum. Its nature, whether aneurysm or new growth, has often to be decided rather by the general or constitutional, than by the physical signs.

In young or old people, the probabilities are in favour of new growth; especially if the cachexia, usual with malignant disease, be present.

On the other hand, in middle aged persons especially in men, the probabilities are in favour of aneurysm. This diagnosis would be confirmed by evidence of vascular change in other parts, as for example by thickened arteries, or by the history of causes likely to produce vascular degeneration, such as laborious work, drink, and syphilis.

In the majority of cases, however, the diagnosis does not present any great difficulties.

SYNOPSIS.

In making the diagnosis of a mediastinal tumour, we have to consider

1. The evidence of a solid mass in the mediastinum, as given
   (*a*) By the **physical signs**,
   (*b*) By the **pressure symptoms**;
2. The facts pointing to the nature of the mass;
   (*a*) **Special physical signs**;
   (*b*) The **age**, **history**, and **constitutional condition** of the patient.

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